

## **Conservation of archeological polychrome glazed ceramics with a focus on detachable gap-fills and perceptible retouching**

16<sup>th</sup>-century basket-shaped ceramics from the Salzburg Museum



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For the obtention of the:

Master of Arts HES-SO in Conservation-restoration

Specialized in archeological and ethnographical objects

Academic year 2022-2023

Submission: 17 July 2023

Jury: 30-31 August 2023

Number of pages: 164



## Engagement

*« J'atteste que ce travail est le résultat de ma propre création et qu'il n'a été présenté à aucun autre jury que ce soit en partie ou entièrement. J'atteste également que dans ce texte toute affirmation qui n'est pas le fruit de ma réflexion personnelle est attribuée à sa source et que tout passage recopié d'une autre source est en outre placé entre guillemets. »*

Morges, le 14.07.2023,

Zoé Meyer de Stadelhofen

## Acknowledgments

This thesis could not have been accomplished without the help and support of many people whom I wish to thank:

Maximilian Bertet, conservator of archaeological objects at the Salzburg Museum and my internship coordinator, for his time, availability, precious help and advice, organization, kindness, and trust.

Caroline Mottais, conservator specializing in ceramics and glass, professor of the BA ceramics and glass course at the Haute-Ecole arc (HE-arc), and my mentor, for her wise advice, help, availability and proofreading of my work.

From the Salzburg Museum, I also wish to thank Ulrike Hampel, scientific collaborator in archaeology, for her help in research, her opinions, and her enthusiasm. From the conservation lab, Judith Niedermair-Altenburg, head of conservation, Liesa Brierley, and Karin Braun, conservators, for lending me materials and space and for their kindness and helpful advice. Also, Dr. Holger Wendling, head of the archaeology department, for organizing my stay in Salzburg. Finally, all the collaborators of the Salzburg Museum I had the chance to meet and talk with for their warm welcome and kindness.

The teachers' college, especially Valentin Boissonnas, conservator, professor of the metal conservation courses at the HE-arc, and my reference teacher during this work, for the time taken to correct and discuss my work. Dr. Christian Degriigny, professor and research project manager at the HE-arc, for his help, availability, and efficiency in realizing XRF analysis. Dr. Régis Bertholon, director of the conservation-restoration sector at the HE-arc, and Tobias Schenkel, professor of the technical objects courses at the HE-arc, for their guidance while preparing this work.

For producing the Raman and SEM-EDS analysis, Dr. Nadim Scherrer, professor and analyst at the Hochschule der Künste, Bern (HKB).

Sandra Gillioz, conservator of archaeological and ethnographical objects and specialized technician at the Lausanne Historical Museum, for her advice, helpfulness, encouragement, and kindness. Fanny Fiol, an independent conservator specializing in ceramics and glass, for her guidance, resources, kindness and availability; Rainer Geschke, conservator specializing in ceramics, glass, and stone, for her advice and for answering my questions on my testing protocol. Julian Brosius, conservator of archaeological objects at the Römisch-Germanisches Zentralmuseum in Mainz, for sending me resources and a recording of a conference he has done.

Pia Edqvist, conservator of archaeological objects at the Museum of Cultural History in Oslo and co-director of social sustainability at Ki-culture, for answering my questions concerning ethics in

conservation. Eleonore L'Hostis, independent conservator specializing in ceramics and glass, for sharing her publication and photos with me and for her interest.

Anne Cuenat, librarian at the HE-arc, for scanning articles and making them available to me.

My other proofreaders, not cited earlier, are Julie Vuignier, conservator at the Kulturmuseum in St-Gallen; Anne Meyer de Stadelhofen, Théo Baudère, and Bastien Waeny, also for their encouragement and support. My friends and family who supported me from a distance, or came to visit me in Salzburg, for giving me strength and motivation to continue.

Lastly, I wish to warmly thank my student colleagues, Victorine Dam, Ash Dupuis, Delphine Rubin, and Annick Simon, for their unwavering presence, help, support, patience, humor, and kindness.

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## Abstract

In 1994, an archaeological excavation took place in the basement of the Schatz-Haus in the center of the old town of Salzburg, Austria. There, many objects from the early modern era were found. Five polychrome, glazed, "basket-like" ceramics were singled out from these objects for their historic and aesthetic values and rarity. Interestingly, no comparable objects were found in the Salzburg Museum's collection, nor museums of the region. The most complete object, which received particular attention during the conservation process, is a small apertured vessel featuring repetitive imprinted motifs of a late 16th-century woman (depicted on the title page).

The first step in this work was to study the ceramic sherds. Through macroscopic and microscopic observations, as well as analysis using techniques such as XRF, Raman, and SEM-EDS, the fabrication techniques and materials could be better understood. This also allowed us to create a condition report and better understand the deterioration processes affecting the glazes. With comparison of the objects and those in museum databases, and art historical contextualization, efforts were made to determine a more precise dating and geographical origin.

At the beginning of this work, the objects were slightly soiled and in a fragmented, incomplete state. Some glazes also had a fragility problem, with risks of flaking. The museum's goal was to study these objects, potentially publish research findings, and include them in a future exhibition. The conservation work aimed to better the conservation conditions by limiting the risk of dissociating fragments, and making the objects physically stable. It also aimed to enhance the aesthetic appeal and comprehensibility of these objects.

After research and testing, the conservation process commenced, involving cleaning, glaze re-adhesion, and bonding. For the most complete of the vessels, detachable gap-fills were created. These gap-fills are made in a way that the plaster can be re-worked apart from the object. This limits risks such as scratching the object's surface and embedding plaster dust into it. The gap-fills are then glued to the object, enabling reversibility and achieving a fragmented appearance appropriate for archaeological artifacts.

The focus on detachable gap-fills was of interest due to the limited literature available on this topic and the object's complex geometry and polychromy. While conservators typically use molds to create missing sherds, some pieces could not be replicated in this manner, necessitating innovative solutions. With gap-fills in general, there is also a big challenge with retouching, and finding a way to obtain a discernible yet discreet effect. At the end of this work, the five objects could be conserved according to plan and were packed to allow for the best conservation conditions possible for storage and eventual transport.

## Zusammenfassung

Im Jahr 1994 fand im Keller des Schatz-Hauses im Zentrum der Salzburger Altstadt (Österreich) eine archäologische Ausgrabung statt. Dabei wurden zahlreiche Objekte aus der frühen Neuzeit entdeckt. Fünf polychrome, glasierte "korbartige" Keramiken wurden aufgrund ihres historischen und ästhetischen Wertes sowie ihrer Seltenheit aus diesen Funden ausgewählt. Interessanterweise fanden sich keine vergleichbaren Objekte in der Sammlung des Salzburg Museums oder in den Museen der Region. Das am besten erhaltene Objekt, dem während der Restaurierung besondere Aufmerksamkeit gewidmet wurde, ist ein kleines durchbrochenes Gefäß mit sich wiederholenden geprägten Motiven einer Frau aus dem späten 16. Jahrhundert (auf der Titelseite abgebildet).

Der erste Schritt dieser Arbeit bestand aus der Untersuchung der Keramikscherben. Durch makroskopische und mikroskopische Beobachtungen sowie Analysen mit Techniken wie der Röntgenfluoreszenzanalyse (XRF), Raman-Spektroskopie und energiedispersive Röntgenspektroskopie (REM-EDS) konnten die Herstellungstechniken und Materialien besser verstanden werden. Dadurch war es auch möglich, einen Zustandsbericht zu erstellen und die Verfallsprozesse der Glasuren genauer zu erfassen. Durch den Vergleich der Objekte mit denjenigen in Museumsdatenbanken und durch die kunsthistorische Kontextualisierung wurde versucht, das Alter und den geografischen Ursprung dieser Objekte möglichst genau zu bestimmen.

Zu Beginn der Arbeiten waren die Objekte leicht verschmutzt und befanden sich in einem fragmentierten, unvollständigen Zustand. Einige Glasuren wiesen zudem Brüchigkeit auf und es bestand die Gefahr des Abblätterns. Das Zielvorgabe des Museums bestand darin, diese Objekte zu untersuchen, möglicherweise Forschungsergebnisse zu veröffentlichen und sie in einer zukünftigen Ausstellung zu präsentieren. Die Konservierungsarbeiten hatten zum Ziel, die Erhaltungsbedingungen zu verbessern, indem das Risiko des Verlusts oder der Trennung von Fragmenten minimiert und die physische Stabilität der Objekte gewährleistet wird. Dabei sollte auch die ästhetische Wirkung und die Lesbarkeit der Objekte verbessert werden.

Nach den Untersuchungen und Tests begann der Konservierungsmassnahmen, die Reinigung, die Wiederanbringung der Glasur und das Verkleben umfassten. Für die am besten erhaltenen Gefäße wurden herausnehmbare Füllungen aus Gips hergestellt. Diese Füllungen wurden so erstellt, dass sie vom Objekt entfernt werden können, um mögliche Schäden an der Oberfläche des Objekts zu vermeiden und keine Gipsstaubrückstände einzubetten. Die Füllungen wurden anschließend reversibel mit dem Objekt verklebt, um sie genügend zu stabilisieren und gleichzeitig ihr fragmentiertes Aussehen zu bewahren, welches für archäologische Artefakte angemessen ist.

Der Fokus der Arbeit auf abnehmbaren Füllungen ist aufgrund der begrenzten Literatur zu diesem Thema und der komplexen Geometrie und Polychromie der Objekte interessant. Üblicherweise werden in der Restaurierung Gussformen erstellt, um fehlende Scherben nachzubilden, jedoch konnten einige Stücke auf diese Weise nicht reproduziert werden, wodurch innovative Lösungen gefunden werden mussten. Bei Füllungen im Allgemeinen stellt sich auch die Frage der Retusche, also wie ein erkennbarer, aber dennoch diskreter Effekt erzielt werden kann.

Am Ende dieser Arbeiten konnten die fünf Objekte plangemäss konserviert und entsprechend verpackt werden, um die bestmöglichen Erhaltungsbedingungen für die Lagerung und den eventuellen Transport zu gewährleisten.

## Résumé

En 1994, des fouilles archéologiques ont eu lieu dans le sous-sol de la Schatz-Haus, au centre de la vieille ville de Salzbourg en Autriche. De nombreux objets datant du début de l'époque moderne y ont été découverts. Parmi ces objets, cinq céramiques polychromes et vernissées en forme de panier ont été sélectionnées en raison de leur valeur historique, esthétique et de leur rareté. Il est intéressant de noter qu'aucun objet comparable n'a été trouvé dans la collection du musée de Salzbourg ni dans les musées de la région. L'objet le plus complet, qui a fait l'objet d'une attention particulière lors du processus de conservation-restauration, est un petit récipient ajouré présentant des motifs estampés répétitifs d'une femme de la fin du XVIe siècle (illustré en page de titre).

La première étape de ce travail a consisté à étudier les tessons de céramique. Grâce à des observations macroscopiques et microscopiques, ainsi qu'à des analyses utilisant des techniques telles que la Spectroscopie à Fluorescence des Rayons X (FRX), la Spectroscopie Raman et la Microscopie Electronique à Balayage associée à l'analyse par Energie Dispersive de Rayons X (MEB-EDX), les techniques de fabrication et les matériaux ont pu être mieux compris. Cela nous a également permis d'établir un constat d'état et de mieux comprendre les processus de détérioration affectant les glaçures. En comparant les objets avec ceux des bases de données de musées et en consultant l'histoire de l'art, des efforts ont été déployés pour préciser la datation et l'origine géographique des objets.

Au début de ce travail, les objets étaient légèrement souillés et dans un état fragmentaire et incomplet. Certaines glaçures présentaient également des problèmes de fragilité, avec des risques d'écaillage. L'objectif du musée était d'étudier ces objets, d'éventuellement publier les résultats de la recherche et d'inclure les objets dans une future exposition. Les travaux de conservation visaient à améliorer les conditions de conservation en limitant le risque de perte ou de dissociation des fragments et en rendant les objets physiquement stables. Ils visaient également à améliorer l'attrait esthétique et la compréhensibilité de ces objets.

Après des recherches et des tests, le processus de conservation a débuté, impliquant le nettoyage, le re-fixage des glaçures et le collage. Pour les récipients les plus complets, des comblements détachables ont été créés. Ces comblements sont conçus de manière à ce que le plâtre puisse être retiré de l'objet sans difficulté. Cela limite les risques d'endommager la surface de l'objet ou d'y incruster de la poussière de plâtre. Les comblements sont ensuite collés à l'objet, permettant une réversibilité plus facile et créant un aspect fragmenté approprié pour les objets archéologiques.

L'accent mis sur les comblements détachables était particulièrement intéressant en raison du peu de publications disponibles sur le sujet, ainsi que de la complexité de la géométrie et de la polychromie de l'objet. Habituellement, les conservateur-restaurateurs utilisent des moules pour créer des tessons manquants, mais certaines pièces ne pouvaient pas être reproduites de cette manière, ce qui a nécessité la recherche de nouvelles solutions. En ce qui concerne les comblements en général, la question de la retouche se pose également, c'est-à-dire comment obtenir un effet discernable mais discret.

À la fin de ce travail, les cinq objets ont pu être conservés conformément au plan et ont été conditionnés afin de garantir les meilleures conditions de conservation possibles pour le stockage et le transport futur.

# Introduction

In 1994, an archaeological excavation took place in the basement of the Schatz-Haus, a landmark building on the famous *Getreidegasse* in the city of Salzburg. The Salzburg Museum's archaeological department found objects from the 15<sup>th</sup> to the 18<sup>th</sup> centuries belonging to important members of the political and economic life of the city.

The objects of this work are ceramic sherds forming five "basket-like" apertured polychrome glazed vessels. They are significant works of craftsmanship from the beginning of the modern era and are unique to the region. At the beginning of our work, information concerning these objects was scarce, with no comparable objects in the museum and no clue as to their original use and function. A conservator has also never treated the objects since the excavation.

Therefore, this work aims to conserve these objects, allowing for their study, publication, and exhibition. We will first examine the fabrication techniques and materials and try to find comparable objects and possible dates and places of origin through research and compositional analysis. This research will also allow a better comprehension of the peculiar degradation processes, where some glaze colors are more degraded than others on the same object, for example.

The objects must then be treated to improve their stability and long-term conservation and make them easily legible to researchers and the public. The interventions include cleaning, glaze re-adhesion, assembling the sherds, and gap-filling. For this final subject, we will focus on the most complete of the objects, and aim to create detachable gap-fills and comprehensible yet aesthetic retouching. Detachable gap-fills are fills formed separately from the ceramic object – generally by using an isolation layer –, then glued on like a sherd.

The subject of detachable gap-filling in conservation literature is generally scarce. Furthermore, the fact that the object has decorative apertures makes the process significantly more complex. The extent of gap-filling and the realization of comprehensible and recognizable retouching are subjects that do not have a consensus in the profession and are fascinating to look into as well.

# Methodology

The two main research problems of this work are the following:

- Using imaging and analysis techniques, can we better understand these objects' fabrication technology and the glazes' degradation?
- What materials and techniques can create satisfactory detachable gap-fills and retouching for an apertured, polychrome glazed ceramic?

First, the historical context was researched to understand the use and function of these mysterious objects. Comparative research in museum databases and literature was carried out to eventually better date or attribute these objects geographically.

Then, after doing a literature survey to orient our searches, analysis was carried out in the Swiss Conservation-restoration Campus (Swiss CRC) facilities. At the HE-arc, X-Ray Fluorescence spectroscopy (XRF) was done to obtain a semi-quantitative idea of the composition of the ceramic pastes and glazes on three sherds from different objects. Then, at the Hochschule der Künste (HKB), Raman spectroscopy and Scanning Electron Microscopy coupled with Energy Dispersive Spectroscopy (SEM-EDS) were carried out on one sherd. Raman analysis aimed to identify pigments in the glazes. SEM-EDS was used to obtain quantitative results of the glaze composition, and imaging of the glaze surfaces to localize and characterize degradation products.

The conservation treatments were based on experience with techniques and materials, literary research, and testing. The most extensive testing process was for the detachable gap-fills and the retouching, representing this work's particular complexity and focus. Technical and ethical questions were asked to conservation professionals from Austria, France, Germany, Norway, and Switzerland (see *Acknowledgments*). Opinions and advice converged in places and diverged elsewhere, but allowed to orient the materials and techniques testing protocol.

The choice of materials also depended on preliminary research and their price and availability in Austria. Once a list of materials was narrowed down, they were ordered to the museum. A list of qualitative criteria was determined to evaluate the effectiveness and appropriateness of each category of materials, and tests were carried out. By compiling the results of the testing, the most satisfactory materials and techniques were chosen, and a protocol and time estimation could be made.

The objects were treated sequentially during the five months allotted for this thesis. Finally, they were packed individually to allow their conservation in the best conditions possible.

# Part 1: Historical context

## 1.1 The polychrome ceramics of the Schatz-Durchhaus cesspits

### 1.1.1 *Historical context*

The ceramic vessels studied in this thesis were determined to date from the 16<sup>th</sup> century, probably <sup>1</sup>.

Between 1328 and 1803, Salzburg was an independent principality within the Holy Roman Empire of the German Nation, ruled by prince-archbishops <sup>2</sup>. Notable prince-archbishops of the 16<sup>th</sup> century are Leonhard von Keutschach (1495-1519), Matthäus Lang (1519-1540), and Wolf Dietrich von Raitenau (1587-1612). The latter contributed significantly to bringing the Italian Renaissance architecture and style to the city <sup>3</sup>.

The 16<sup>th</sup> century was specifically marked by the writings of Martin Luther being published and large portions of the Western European population turning to Protestantism. To oppose this, Salzburg rulers took part in the counter-reformation and erected numerous baroque churches and religious buildings as a visible sign of the still flourishing catholic faith <sup>4</sup>.

Trade formed the basis of the city's economy, with a boom between the beginning of the 15<sup>th</sup> century and the middle of the 17<sup>th</sup> century. Commerce took place with Venice, Munich, Augsburg, and Linz, thanks to essential roads and traffic on the Salzach River. The economy and politics of the city between the 14<sup>th</sup> and 17<sup>th</sup> centuries were ruled by twenty to twenty-five families. These were town magistrates, mayors, merchants, and entrepreneurs who acquired titles and wealth through long-distance trade or mining (of salt or gold) <sup>5</sup>. A strategically situated place in the city, close to the river and the main commerce routes, and where influential Salzburg personalities lived, happens to be the street where the objects of our study were excavated – the *Getreidegasse*.

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<sup>1</sup> Hampel, 2023 [oral source].

<sup>2</sup> Land Salzburg [online], "Landesgeschichte".

<sup>3</sup> Salzburger Nachrichten, "Geschichte der Stadt Salzburg" [online].

<sup>4</sup> Salzburger Nachrichten, "Geschichte der Stadt Salzburg" [online].

<sup>5</sup> Ruttner, in Feldinger and Kastler, 2008, p.56.

## 1.1.2 Archaeological context

### Geographical context

The city of Salzburg is the capital of Salzburg *Bundesland* (federal state) in north-central Austria. It was built around the Salzach River and used to be partially walled, otherwise delimited by mountains on all sides<sup>6</sup>.

Today a main tourist and shopping destination in the city, the *Getreidegasse* was the most important commercial street in Salzburg during the Middle Ages already<sup>7</sup>. It was cited in 1150 as *Trabgasse* or *Traugasse*. The first trading house was founded in 1509 for iron goods. After that, many other trading houses followed. The street quickly became the top social address for influential citizens – public officials, patricians, merchants – and an economic center for service and commerce<sup>8</sup>.

Characteristic of this city are through-houses (*Durchhäuser*), which are houses with a public passageway. As the previously unbuilt area of the *Frongarten*, between *Getreidegasse* and the *Mönchsberg*, was built in the middle of the 16<sup>th</sup> century, private houses now had to accommodate passages for pedestrians. Indeed, the *Getreidegasse* was, before then, a very long street with few crossings<sup>9</sup>. It is under one of these houses that the objects of our study were excavated (**Fig. 1**).

### The Schatz-Durchhaus

The *Schatz-Durchhaus* is located on *Getreidegasse* n°3. The buildings on this side of the street can be traced back to the middle of the 13<sup>th</sup> century. The Schatz House is associated with various famous Salzburg merchant families, such as the Keuzels in the 14<sup>th</sup> and 15<sup>th</sup> centuries, the Mayr family in the 17<sup>th</sup> and 18<sup>th</sup>, and the Schatz family, who owned the building complex from 1835, and to whom it owes its name<sup>10</sup>. The house saw structural changes as its owners changed over the years.

During the 16<sup>th</sup> century, the house first belonged to Hans Ritzinger, then Hans and Virgil Rauchenberger from 1547 to 1600. They were merchants and worked for the prince-archbishop or at the city council<sup>11, 12</sup>.

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<sup>6</sup> Ruttner, in *Feldinger and Kastler*, 2008, p.56.

<sup>7</sup> Schobersberger, in *Feldinger and Kastler*, 2008, p.17.

<sup>8</sup> Husty and Rinnerthaler, in *Feldinger and Kastler*, 2008, p.11.

<sup>9</sup> Schobersberger, in *Feldinger and Kastler*, 2008, p.17.

<sup>10</sup> Husty and Rinnerthaler, in *Feldinger and Kastler*, 2008, p.7.

<sup>11</sup> Stadt Salzburg [online], "Bürgermeister seit 1370".

<sup>12</sup> Husty and Rinnerthaler, in *Feldinger and Kastler*, 2008, p.10-11.



**Figure 1:** View of Salzburg from the Kapuzinerberg in 1533. Circled in red is the Schatz-Haus.  
© Salzburg Museum

### Excavation context

The opportunity for an archaeological search arose in 1994 when a shop operating on the ground floor of the *Schatz-Haus* since 1900 closed permanently. Renovations were planned under the surveillance of state representatives and the Salzburg Museum. Thus search conditions were not ideal because of the renovation time limits<sup>13</sup>. The excavation lasted eight weeks, and only a fifth of the objects were estimated to have been excavated<sup>14</sup>.

This find was nevertheless significant for the history of the house and the material history for the early modern period. The objects found were of unusual variety and, in quantity and quality, far surpassing other find complexes of the 16<sup>th</sup> and 17<sup>th</sup> centuries in Salzburg<sup>15</sup>.

The excavation took place in the basement of the building. The basement was used as a cesspit<sup>16\*</sup> from the end of the 15<sup>th</sup> century until the middle of the 16<sup>th</sup> century. Then, a central wall was added to the basement, and two 2-meter high pits in one room were still used as cesspits from the middle of the 16<sup>th</sup> to the beginning of the 18<sup>th</sup> century. Finally, the basement was demolished or collapsed

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<sup>13</sup> Kovacovics, in *Feldinger and Kastler*, 2008, p.43-44.

<sup>14</sup> Hampel, 2023 [oral source].

<sup>15</sup> Kovacovics, in *Feldinger and Kastler*, 2008, p.44.

<sup>16</sup> The words marked with an asterisk (\*) can be found in the glossary, p.85-88.

during renovations on the ground floor at the end of the 19<sup>th</sup> century. It was filled with gravel and oven tiles<sup>17</sup>.

When used, the pits were filled with fecal matter and food waste, which solidified into peat. The ground was relatively dry and contained many fragments of ceramic vessels<sup>18</sup>. Glass, wood, metals, horn, bones, stones, and food remains were also found. The objects allowed dating of the different layers and informed on the way of life and the eating habits during these periods<sup>19</sup>.

After the excavation, the archeologists washed the ceramic objects and stored them in the ceramics storage room in the Salzburg Museum facilities. The objects are in the current storage room since the early 2000s, in a climate controlled environment kept between 45-60% relative humidity (RH)\*.

### **1.1.3 Cultural values**

These ceramics are a particular case concerning cultural values. Indeed, they resemble more objects that would be found in decorative arts or historical museums, yet one values different aspects because of their archaeological status. The general public will consider historical objects for their aesthetics and integrity whereas objects of archaeological origin are valued for their ancientness<sup>20</sup>. This will generally impact restoration choices.

Most importantly, these objects have historical value, as they are linked to important families of Salzburg, and to a crucial period in the city's history. This is especially significant as they are the only such polychrome "basket-shaped" ceramics found in the region. These objects are thus also important for archaeological and technical research. They are proof of a rare craft, and can be linked to other significant crafts of the Salzburg area such as tiled stove manufacturing.

The objects, since they are preserved in a museum collection, have a patrimonial and didactic value. They also have inherent decorative and aesthetic values. Although their original functions is not known, they were clearly created in a decorative and possibly demonstrative goal, rather than purely as functional ware.

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<sup>17</sup> Kovacsovics, in *Feldinger and Kastler*, 2008, p.46.

<sup>18</sup> Kovacsovics, in *Feldinger and Kastler*, 2008, p.47.

<sup>19</sup> Kovacsovics, in *Feldinger and Kastler*, 2008, p.48.

<sup>20</sup> Guillemard, 1998, p.7.

## Part 2: Technological study

### 2.1 Composition and fabrication of glazed ceramics

#### 2.1.1 The ceramic body

Ceramic is an inorganic silicate-based material created by firing clay at a temperature higher than 600°C, making it irreversibly insoluble in water and maintaining its given shape<sup>21</sup>.

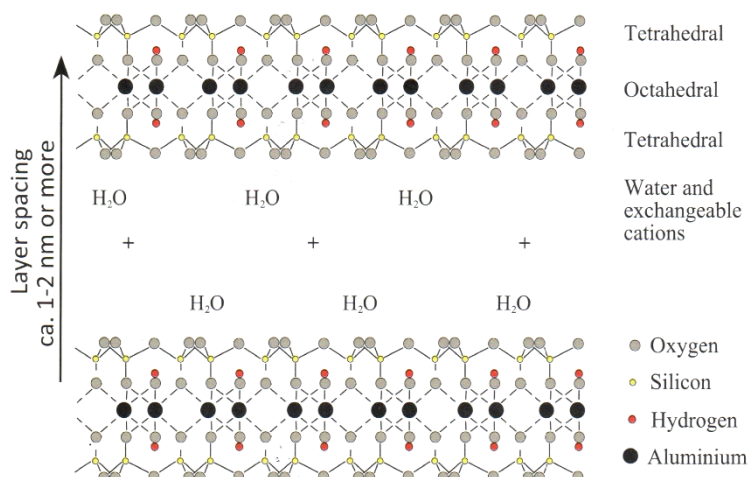
#### Raw materials and their origins

Clay is mainly composed of hydrated silicate of aluminum, formed by the decomposition of metamorphic and igneous rocks of the earth's crust for millions of years<sup>22</sup>. It can be mined in shallow depths of the earth's crust<sup>23</sup>. Clay contains highly plastic\* materials, such as kaolinite, illite, or montmorillonite, non-plastic materials like feldspath and quartz, and impurities like metallic oxides and organic materials.

The silicate material has a layered structure consisting of plate-like particles (formed by SiO<sub>4</sub> tetrahedra) aligned in sheets. Between these sheets are linked Al or Mg atoms (**Fig. 2**). The variations in the geometrical combination of these elements create the many clays found in nature<sup>24</sup>.

The water around the clay platelets allows the material to be cohesive but also acts as a lubricant. This is why clays, if not fired, can be deformed into vessels or objects, become solid by drying, and plastic again when wet<sup>25</sup>.

**Figure 2:** Structure of clay, with water and cations (Mg<sup>2+</sup>, Al<sup>3+</sup>) between the platelets  
© Heimann and Maggetti, 2014.



<sup>21</sup> Oakley and Jain, 2002, p.2.

<sup>22</sup> Oakley and Jain, 2002, p.1-2.

<sup>23</sup> Heimann and Maggetti, 2014, p.160.

<sup>24</sup> Heimann and Maggetti, 2014, p.25-26.

<sup>25</sup> Oakley and Jain, 2002, p.2.

## Preparation

Preparation of clay makes the particles smaller, improving strength and homogeneity<sup>26</sup>. This can be done first by drying, milling, and sieving the clay. Then, it is mixed or soaked in water for an extended period. This increases plasticity and allows unwanted coarse constituents to be eliminated<sup>27</sup>.

Clay can naturally contain some additional components, but these can also be intentionally mixed-in during the preparation phase. **Fluxes** – feldspathic materials and alkaline earth metal oxides, such as carbonates – melt during firing to form a glass-like material that closes the ceramic's porosity\*<sup>28</sup>. Carbonates, in particular, make the ceramic lighter colored when fired at high temperatures but can increase in volume and cause surface flaking<sup>29</sup>. **Hardeners** – flint, mica, quartz, and sand – contribute to the material's hardness and heat resistance after firing but can also increase fragility to breakage. Finally, **openers** – such as grog\* and organic materials – provide texture and workability to the raw clay, and reduce shrinkage while drying, but can also increase porosity<sup>30</sup>. Distinguishing between natural and artificial add-ins is very difficult<sup>31</sup>.

## Forming

Clay vessels can be formed by coiling\* or throwing\* on a potter's wheel. Throwing requires clay that is homogenous, soft, plastic, and free of coarse constituents<sup>32</sup>. It is faster, allows for better symmetry, and can sometimes be recognized by turning and trimming marks\*.

The process of creating object 7216 is illustrated on the next page.

Relief appliques, as seen on objects 7216 and 7217 (**Fig. 10 and 11**), are formed in molds. These molds were generally made of low-temperature fired clay or plaster. These materials had important porosity, allowing them to extract moisture from the clay pressed into them. The clay was then removed from the mold when it had dried and slightly shrunk. It could also be pressed directly onto the vessel wall to correspond to its curvature. These molds were sometimes exchanged between workshops<sup>33</sup>. To adhere elements such as handles or appliques, the area was roughened on the leather-hard (partially dried) clay vessel, and the elements adhered with the help of a slurry\*. After this, the openings were cut out from the outside. We can see this from the rounded edges of the apertures on the outside of the objects, and protruding on the inside.

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<sup>26</sup> Oakley and Jain, 2002, p.1.

<sup>27</sup> Kaltenberger, 2009, p.165.

<sup>28</sup> Oakley and Jain, 2002, p.1.

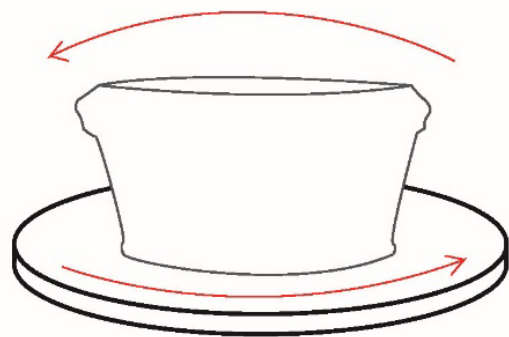
<sup>29</sup> Kaltenberger, 2009, p.176.

<sup>30</sup> Oakley and Jain, 2002, p.1 and Kaltenberger, 2009, p.175.

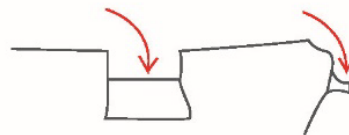
<sup>31</sup> Berducou, 1990, p.83.

<sup>32</sup> Heimann and Maggetti, 2014, p.44.

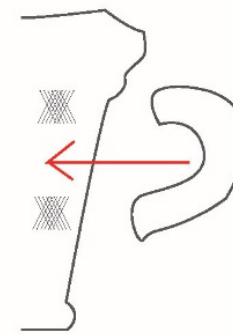
<sup>33</sup> Kaltenberger, 2009, p.208.



1. Throwing and turning of a bowl

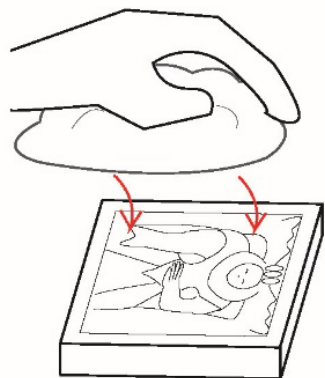


2. Cutting and deforming the lips

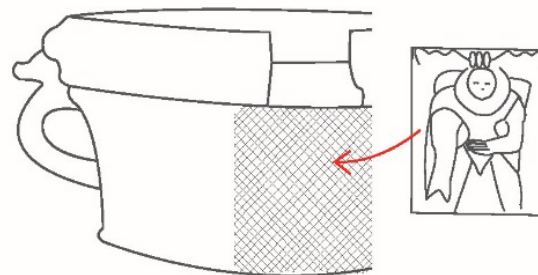


3a. Shaping the handles.

3b. After scratching the surface, attaching the handles with a slurry.



4. Pressing clay into the mold



5a. Drying and removing of the relief from the mold

5b. Attaching the relief applique to the bowl



6. Cutting out the apertures

**Figure 3:** Process of fabrication of object 7216

## Drying and firing

After forming, the clay object is dried for several days. This avoids cracking during firing, caused by the forces of occluded water trying to escape<sup>34</sup>. Drying increases pore size and causes retraction, creating tensions in areas of differential thickness and humidity<sup>35</sup>, sometimes exhibited in cracks (Fig. 4).

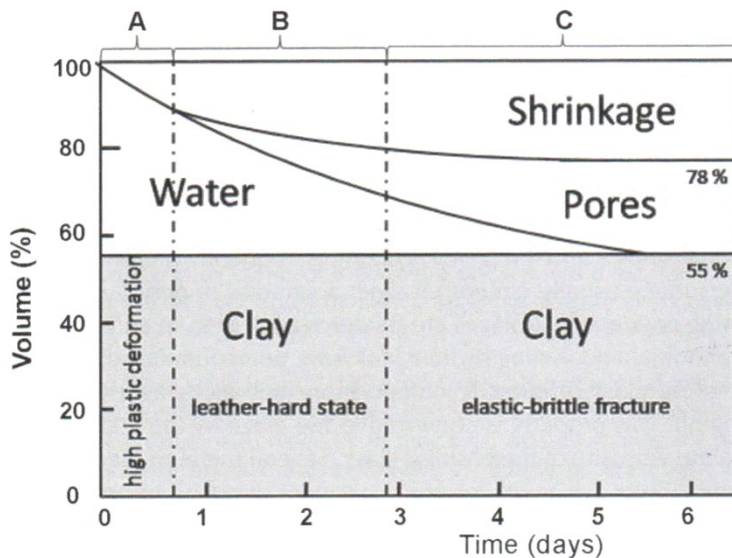


Figure 4: Typical drying diagram for clay masses

© Heimann and Maggetti, 2014

During firing, the chemically linked water is evacuated, leading to permanent and irreversible cohesion between the clay particles<sup>36</sup>. The temperature in the kiln is gradually raised, and the chemically combined water escapes at approximately 600°C<sup>37</sup>. At about 800°C, vitrification or sintering starts to occur, thanks to fluxes. Silica and fluxes fuse together, cementing the ceramic body strongly and diminishing porosity<sup>38</sup>. The higher the firing temperature is, the lower the porosity becomes.

Seeing the low porosity and light color of the ceramics studied here, they most likely were fired up to 1150°C, followed by a second firing under 1100°C, with their polychrome glaze<sup>39</sup>. Typically, fine, lightly colored earthenware\* have a porosity between 2 and 6% of their mass<sup>40</sup>.

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<sup>34</sup> Heimann and Maggetti, 2014, p.47.

<sup>35</sup> Berducou, 1990, p.85.

<sup>36</sup> Berducou, 1990, p.85.

<sup>37</sup> Oakley and Jain, 2002, p.8.

<sup>38</sup> Berducou, 1990, p.86.

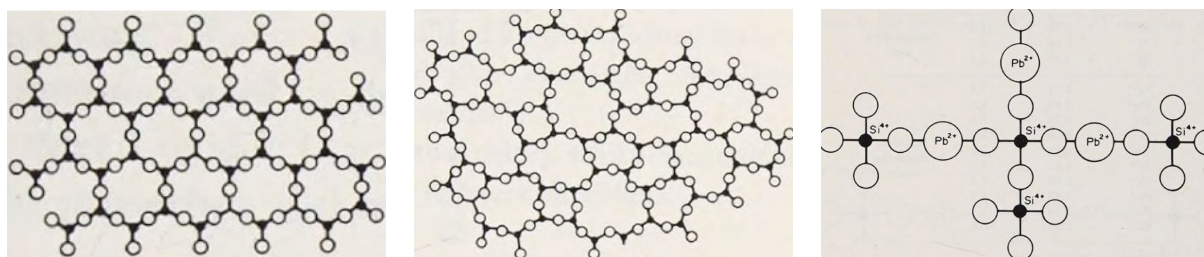
<sup>39</sup> Oakley and Jain, 2002, p.3-4.

<sup>40</sup> Heimann and Maggetti, 2014, p.13.

### 2.1.2 The glaze

Glazes are low-temperature melting glassy materials made from quartz and metal compounds as fluxes. They create vitreous silicate coatings on the ceramic body. In addition to decorative purposes, they give the ceramic products new properties, such as sealing their porous body with a dense, smooth, hard, and hygienic coating<sup>41</sup>. In most cultures, glazed ceramics were a prestigious good<sup>42</sup>.

The coating appears transparent and glossy because it is a non-crystalline solid<sup>43</sup>. This structure is formed when the silicate glass-forming material ( $=\text{Si-O-Si}=\text{}$ ) is heated enough, then recombined with metal oxide cations (forming, for example,  $=\text{Si-O-Ca-O-Si}=\text{}$ ) while cooling. These three phases are represented below (**Fig. 5**).



**Figure 5:** Left: crystalline "glass". Middle: amorphous glass. Right: silica network, recombined with metal cations  
© Taylor and Bull, 1986

Although it is helpful to compare glass and glazes because of their compositional similarities, they have to be considered like different materials. Indeed, glass is kept at high temperatures for long periods to ensure all the raw materials melt and the structure is homogenous. This is not the case with glazes because the clay might begin to be affected by the heat. Therefore, glazes generally retain impurities such as crystalline raw material and bubbles<sup>44</sup>. Pre-fritted glaze partly modifies that *status quo*, as will be seen later.

### Materials

In the period and geographical context studied here, we can consider that glaze composition is generally comprised of a **glass former** (quartz or sand), a **flux** (commonly lead oxides, but also calcium, potassium, sodium, and magnesium oxides), and a **stabilizer** (often ground ceramic, providing aluminum oxide)<sup>45</sup>. The flux lowers the glass former's melting temperature from 1600°C to

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<sup>41</sup> Kaltenberger, 2009, p.218.

<sup>42</sup> Vandiver, 1990, p.107.

<sup>43</sup> Taylor and Bull, 1986, p.2.

<sup>44</sup> Vandiver, 1990, p.107.

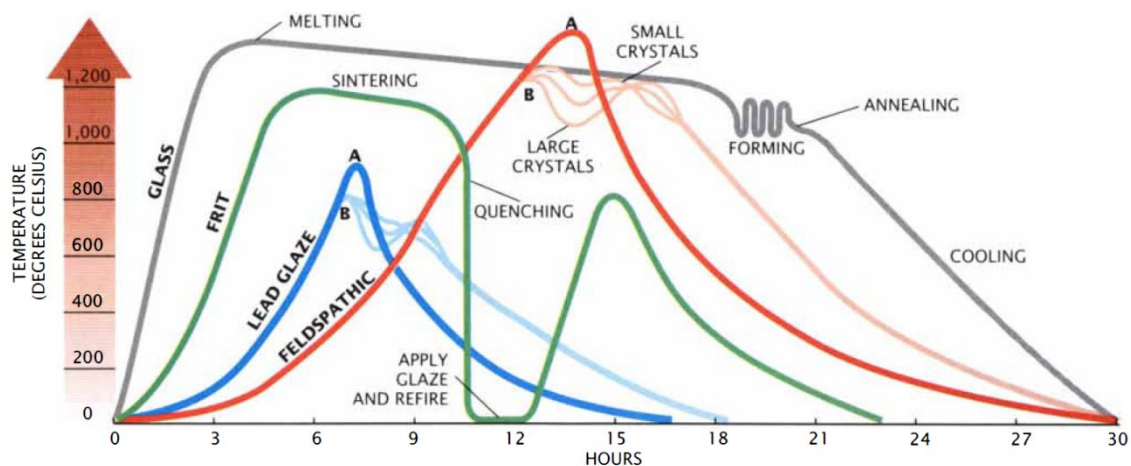
<sup>45</sup> Kaltenberger, 2009, p.218.

under 1100°C. The stabilizer serves to make the amorphous glass network stable. The presence of powdered ceramic in the glaze also helps better its adhesion to the ceramic substrate, and the chemical stability of lead glazes<sup>46</sup>. Glaze preparation varies a lot regionally and through time and can contain a variety of other components. General principles applicable to our study period are described in the following sections.

### Raw or frit glazes

Raw glazes are composed of inorganic substances that require no prior preparation. Lead, quartz and ceramic are ground together in a fine powder and mixed in water.

Frit glazes use prefabricated glass fluxes. They are created by firing the same raw materials together, then finely grounding the obtained fused glass into a powder<sup>47</sup>. This technique solves the lead toxicity problem, diminishes the number of defects and bubbles, and allows for firing on the ceramic at lower temperatures (**Fig. 6**)<sup>48</sup>. Frit glazes are also supposedly less susceptible to crazing or cracking than raw glazes<sup>49</sup>.



**Figure 6:** Thermal history of glass, frit glaze, lead (raw) glaze and feldspathic glaze (porcelain glaze)  
© Vandiver, 1990

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<sup>46</sup> Kaltenberger, 2009, p.220.

<sup>47</sup> Kaltenberger, 2009, p.230.

<sup>48</sup> Vandiver, 1990, p.110.

<sup>49</sup> Kaltenberger, 2009, p.231.

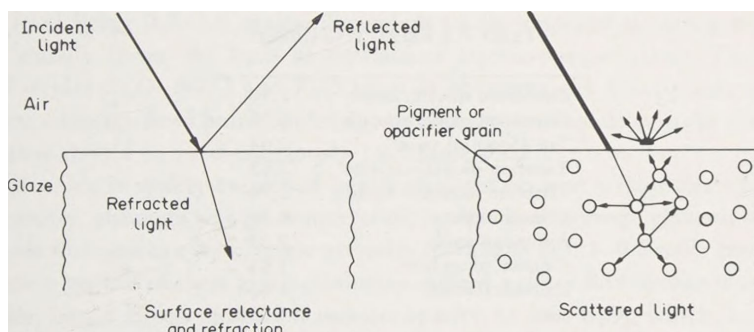
## Opaque glaze

Frit glazes can be opacified with tin oxide (cassiterite). A lead-tin ash is first created by heating them in an oxidizing atmosphere, which bonds the metal compounds<sup>50</sup>. Islamic potters first discovered tin glazes in an attempt to copy Chinese porcelain. This knowledge was introduced to Spain and Italy soon after 1200 and later in the rest of Europe<sup>51</sup>.

It should also be considered that opacification can occur from other causes, intentional or accidental. First, bubbles in the glaze can be created by adding carbonates or sulfates<sup>52</sup>, or unintentionally because of the presence of calcium phosphate and silicate or lead arsenate<sup>53</sup>. Finally, a glaze will appear opaque if more than 10% of the volume of the glassy material is in crystalline form<sup>54</sup>, which can happen because of faulty fabrication or degradation.

## Colorants

To color glazes, transition metal\* compounds are dissolved into the glaze or put in suspension in it (**Fig. 7**)<sup>55</sup>. These transition metals have an outer electron layer that absorbs all but specific light wavelengths, making them colorful to the eye. The color obtained will depend on their pH, oxidation level, and concentration<sup>56</sup>. Some oxides resist high firing temperatures (around 1000°C) and are applied on the glaze before firing. These oxides appear as are brown, green, yellow, orange/red, and blue. This limited color palette is representative of a period in ceramics production, generally before the 18<sup>th</sup> century and is found on all the studied objects.



**Figure 7:** Refraction, scattering, and absorption of light in a glaze

© Taylor and Bull, 1986

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<sup>50</sup> Kaltenberger, 2009, p.220-221.

<sup>51</sup> Wilson, 2013, p.6.

<sup>52</sup> Colomban, 2019, p.6.

<sup>53</sup> Colomban, 2019, p.8.

**Note:** Lead arsenate can be present in glazes because of the potentially high arsenic content in the blue colorant (cobalt).

<sup>54</sup> Vandiver, 1990, p.109.

<sup>55</sup> Taylor and Bull, 1986, p.39.

<sup>56</sup> Vandiver, 1990, p.108.

## Application of glaze and colors

Glazed ceramics can be once- or twice-fired (or more). This means the glaze can be applied to an uncooked vessel, or to a biscuit\*. Once-fired vessels are less expensive, but this is offset by a higher rate of rejects because the glaze must withstand a more significant shrinkage margin and water evaporation from the ceramic body, often resulting in defects<sup>57</sup>.

Glaze is applied on a dry and dust-free vessel to avoid flaking during firing. Raw glazes could be applied as a powder on top of a raw engobe or slip, or dissolved in water. Frit glazes are a suspension of the glaze powder in water. In our case, all of the glaze colors were most likely simultaneously painted on a biscuit, without intermediary firings. In fact, one can see the colors blend together in places (**Fig. 8**).



*Figure 8: Glaze colors mix together and do not have precise delimitations.*

Glaze then dries and becomes powdery as the water is absorbed in the ceramic. The bottom of the vessel must be rubbed clean so it does not stick in the kiln. Upscale items like these were glazed on both sides, whereas functional ware was only glazed on the inside<sup>58</sup>.

Colors can be applied in three ways: underglaze, in-glaze or overglaze. **Underglaze** (metallic oxides in a medium) is applied on the biscuit, before applying a clear glaze on top. **In-glaze** colors are included in the glaze composition, or painted onto a raw transparent glaze before firing. **Overglaze** colors are applied on an already fired glaze, and fired at lower temperatures, which is the case for more recent and detailed polychromy<sup>59</sup>. This is illustrated in the diagram below. It is most likely the objects of our study were only fired twice, and have in-glaze colors.



*Figure 9: Firing process of glazed ceramics*

<sup>57</sup> Kaltenberger, 2009, p.231-232.

<sup>58</sup> Kaltenberger, 2009, p.233-234

<sup>59</sup> Oakley and Jain, 2002, p.7.

## 2.2 Descriptions of the objects

The objects are five of the many ceramics found in the 1994 archaeological search in the Schatz-Haus. They are particular because of their polychrome glazes and "basket-like" shapes. They are glazed with yellow, green, light blue, dark blue and white colors. A detailed descriptive datasheet of each object can be found in the appendix, p. 89 to 93.

Objects **7216** and **7217** are extremely similar, as they are circular flat-based dishes with four lips on the top edge and two handles. They have the same glaze and some identical relief appliques, representing the figure of a woman wearing a dress under an archway. Object 7217 differs as it also has an oval crest-like relief and some botanical decors. Their bases are mostly missing, and could have had feet which are now lost, as there are remains of glaze on the bases. This could also just be a manufacturing mistake.



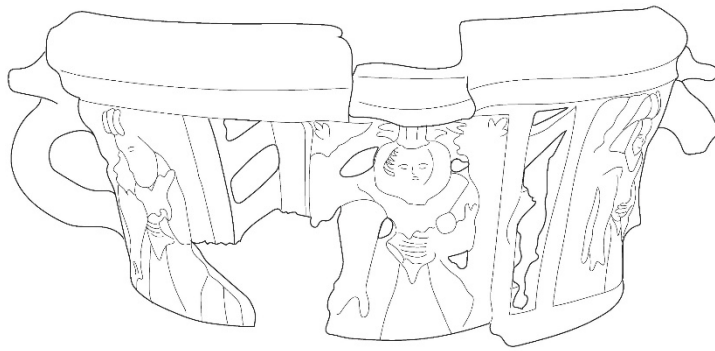
*Figure 10: ARCH 7216-94, before intervention*

*© M. Bertet, Salzburg Museum*

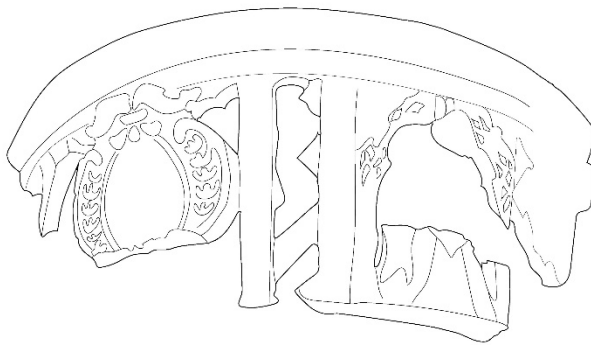


*Figure 11: ARCH 7217-94, before intervention*

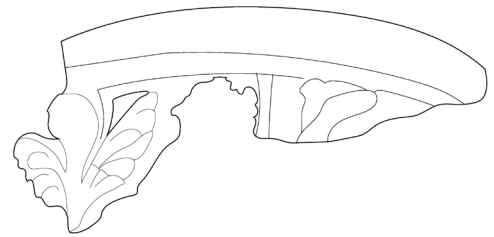
*© M. Bertet, Salzburg Museum*



**Figure 12:** Drawing of ARCH 7216-94



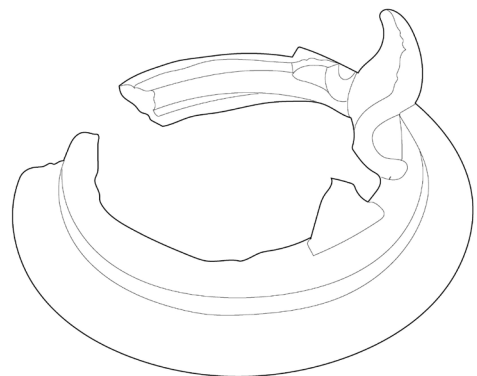
**Figure 13:** Drawing of ARCH 7217-94



Object **7218** is the circular base of an object. It has S shaped rectangular elements fixed to it, and its upper part is completely missing.



**Figure 14:** ARCH 7218-94, before intervention



**Figure 15:** Drawing of ARCH 7218-94

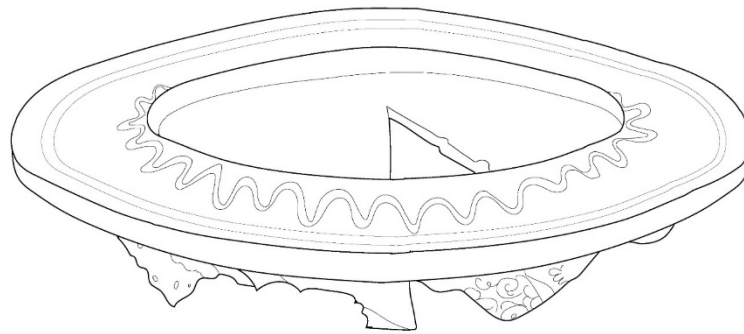
Object **7219** is either a base or a lid of a vessel. It used to also have some attached floral elements and bands, but they are for the most part missing.



*Figure 16: ARCH 7219-94, before intervention*



*Figure 17: ARCH 7219-94, before intervention*

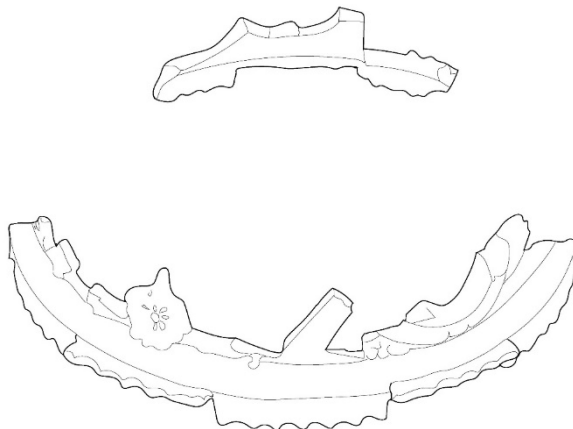


*Figure 18: Drawing of ARCH 7219-94*

Finally, object 7220 is mostly the remains of the top edge of an object, with scalloped lips and a few remains of florals, bands and scalloped decors. Four fragments of the body of the object subside, one being a piece of a handle, formed by the twisting of three coils.



**Figure 19:** ARCH 7220-94, before intervention



**Figure 20:** Drawing of ARCH 7220-94

## 2.3 Technological study

### 2.3.1 *Historical documentation and objects comparisons*

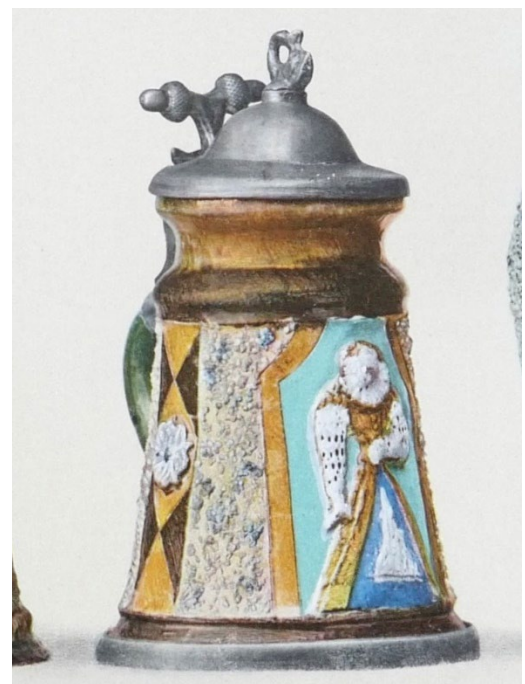
As no comparable object has been documented in the Salzburg region, many questions subside concerning dating, use and manufacture of these ceramic objects. Therefore, comparative research in museum databases and literature has been carried out, in order to maybe find research leads.



**Figure 21:** Part of a stove tiling with apertured decorations,  
1570-1600 © Salzburg Museum

The imprinting technique used on the appliques of objects 7216 and 7217 is similar to the technique used for creating stove tiles. These are particularly common in the region, and were produced in Salzburg and surrounding areas of Austria and Germany, notably in Nuremberg.

Molds were most likely used for the creation of several objects. In fact, a pitcher with an extremely similar figure was found (**Fig. 22**). It dates from the 16<sup>th</sup> century and said to be "coming from Wels, inspired by the works of Reinhart from Nuremberg"<sup>60</sup>. Wels was an important industrial city of upper Austria, with annual markets bringing merchants from Vienna, Linz, Salzburg, etc<sup>61</sup>. It is probable that the same mold has been used for the objects of our study. If this is the case, the objects could therefore have been produced in Wels, or elsewhere through exchange of tools between manufactures.



**Figure 22:** 16th century pitcher with a very similar imprinted motif of a woman  
© Walcher Ritter von Molthein, 1906

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<sup>60</sup> Walcher Ritter von Molthein, 1906, Tafel IX.

<sup>61</sup> Walcher Ritter von Molthein, 1906, p.17.



**Figure 23:** Double walled apertured bowl with two handles, Peter Graf, 1627 © MAK

Secondly, an object of similar shape, glazing and size to objects 7216 and 7217 was found in the MAK\* in Vienna (**Fig.23, 24 and 25**). It is signed and dated "Peter Graf, 1627". It differs from the objects from Salzburg as it has double walls. The bowl also has three feet. It is possible the Salzburg objects also used to have feet, as their bottom has glazing. The dating of the MAK object is slightly posterior to our presumed dating.



**Figure 24:** Inside of the bowl with the artisan's name and date of fabrication © MAK



**Figure 25:** Bottom of the bowl with polychrome glazing and three dice-shaped feet © MAK

One other possibly interesting piece of evidence contained in these objects is the clothing worn by the anthropomorphic figure. It could be correlated with fashion history and portraits of the period. 16<sup>th</sup> century womens' fashion was marked by bulbous sleeves, which can clearly be seen on the object. One could even interpret the relief on the sleeves as slashed sleeves, which were in fashion since approximately 1520<sup>62</sup>. Since the 1540s, women wore farthingales, a skirt understructure giving it a conical triangular shape. This was accompanied by an inverted V shape at the front of the gown (**Fig. 26, 27 and 28**)<sup>63</sup>.

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<sup>62</sup> De Young, "1520-1529", 2019, [online].

<sup>63</sup> De Young, "1540-1549", 2019 [online].



**Figure 26:** Slashed sleeves and farthingale understructure on the portrait of a young woman from 1567  
© Yale Center for British Art



**Figure 27:** Portrait of Catherine de Medici wearing a farthingale, inverted V-shaped skirt forepart and voluminous sleeves in 1559  
© Uffizi Galleries



**Figure 28:** Woman's figure on object 7216



**Figure 29:** Portrait of Catherine of Austria wearing a large ruffled collar and fish-scale motif dress in 1595  
© Palazzo Madama, Turin

In the Holy Roman Empire in the middle of the 16<sup>th</sup> century, womens' dress was characterized by a rigid bodice, a farthingale skirt with a rich forepart in the front of the skirt, cap sleeves and large sleeves protruding underneath them. Standing chemise collars were in fashion since the 1550's and progressively turned into large ruffs in the 1580s<sup>64</sup>. Large and ostentatious clothing was a sign of wealth and power in the Catholic countries. This is extremely similar to what is represented on objects 7216 and 7217. A portrait of Catherine of Austria bears some resemblance to the figure (**Fig. 29**), with a large ruff and headpiece, and fish-scale motifs on the dress, which could be another interpretation of the reliefs on the sleeves. Research into fashion history therefore corroborate the idea that **the objects 7216 and 7217 probably were produced during or after the second half of the 16<sup>th</sup> century.**

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<sup>64</sup> Bochiocchio, 2019 [online].

### 2.3.2 *Characterization of the material composition*

XRF, Raman and SEM-EDS analysis were carried out in order to characterize the chemical nature of the ceramic body, the glazes and the colorants. Three fragments (from objects 7216, 7219 and 7220) were analyzed with XRF, and only one from 7216 with Raman and SEM-EDS, because of time constraints. The complete data and interpretation of the results can be found in the appendix<sup>65</sup>. Here we will concentrate on glazing materials.

#### **Glaze manufacturing**

The glazes were unsurprisingly found to be **lead-silicate based**. Lead is a strong flux and network modifier. It also dissolves metal oxide colorants very well and creates high shine, low viscosity glazes which are commonly used for firing under 1100°C<sup>66</sup>.

The glaze on object 7216 contains a feldspar (probably microcline<sup>67</sup>) and impurities, namely iron, aluminum, arsenic, magnesium, calcium and potassium<sup>68</sup>. The arsenic will be discussed later. The Mg and Ca, present intentionally or not, act as fluxes and reduce the viscosity of the glaze<sup>69</sup>. Potassium is a water-soluble alkali metal, and glazes containing it must therefore be fritted<sup>70</sup>.

No matter the color, the basic glaze composition does not vary significantly throughout the same object. Since the glaze contains lead oxide, the particulates in suspension give it a yellowish color. We can also see in the SEM images just how badly the dark blue color is degraded. Seeing that the glaze composition is the same on the whole object, this is likely linked to defects that occurred during and after firing, possibly due to the use of too coarse pigments<sup>71</sup>.

The **dark blue** color was obtained thanks to small quantities of cobalt, probably used in the form of smalt, a glass frit containing cobalt. Indeed, in Raman analysis on object 7216, a silicate-cobalt compound was found<sup>72</sup>. Cobalt is a powerful colorant and as little as 0,02% of it can produce a noticeable tint in a transparent glaze<sup>73</sup>.

The cobalt blue colorant is particularly interesting when studying ceramic technology because the presence of trace elements can inform us of the oxide's dating, and geological origin. After the 12<sup>th</sup> century, cobalt was discovered as a bi-product of silver mining in the Erzgebirge mountains in

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<sup>65</sup> **Appendix 9** "Analytical data": p.98-131.

<sup>66</sup> Taylor and Bull, 1986, p.37.

<sup>67</sup> **Appendix 9.2** "Raman spectroscopy": p.108-110.

<sup>68</sup> **Appendix 9.1** "XRF": p.99, 102-103 and **Appendix 9.3** "SEM-EDS": p.112-131.

<sup>69</sup> Taylor and Bull, 1986, p.28.

<sup>70</sup> Taylor and Bull, 1986, p.20 and 22.

<sup>71</sup> Kaltenberger, 2009, p.234.

<sup>72</sup> **Appendix 9.2** "Raman spectroscopy": p.108-110.

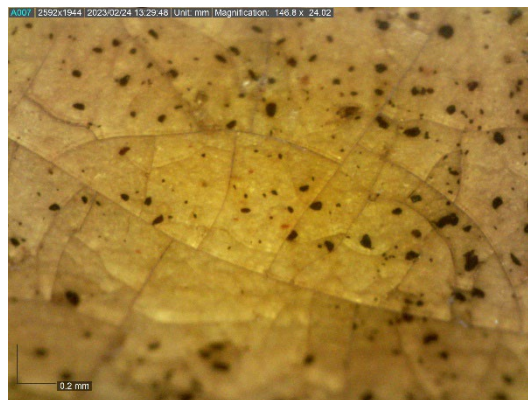
<sup>73</sup> Taylor and Bull, 1986, p.41 and 42.

Saxony<sup>74</sup>. Cobalt from these mines replaced the Middle-Eastern supply entirely for Europeans by 1500<sup>75</sup>. Analytical research has proven that 16<sup>th</sup>-century cobalt pigments in ceramics contained a higher arsenic and bismuth content than during other periods, until the 18<sup>th</sup> century<sup>76</sup>. This change happened in all of Europe and could be linked to a new way of refining the sulpho-arsenate cobalt minerals from the Erzgebirge mines, thanks to a boom in ceramic production and the consequent industrialization of pigment transformation<sup>77</sup>.

Arsenic was found with the XRF analysis, and was determined as possible during SEM-EDS and seen as tiny crystals in the blue glaze. Although we did not find a notable amount of bismuth, we can claim that the cobalt pigment – at least on object 7216 – most likely originates from the Erzgebirge mines<sup>78</sup>. It is nevertheless curious and currently inexplicable that arsenic is present in all colors of glazes on three objects, up to 2%<sup>79</sup> in weight. Its use during this time period is not well documented in literature<sup>80</sup>.

The **light blue** color surprisingly did not contain cobalt but copper oxide and tin oxide (cassiterite)<sup>81</sup>. The tin is present in the form of small needle-like crystals, and not dissolved homogeneously in the glaze. It serves as an opacifier.

The **green** color was obtained thanks to small quantities of copper oxide<sup>82</sup>. Finally, the **yellow** colored glaze did not contain any notable colorants, so it probably owes its color to the presence of lead oxides and iron oxides or hydroxides<sup>83, 84</sup>. The difference in color intensity between the inside and the outside of the objects could be due to glaze thickness and speckling of small dark particulates of silicon dioxide (**Fig. 30**).



*Figure 30: Yellow glaze with dark specks (7220)*

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<sup>74</sup> Zucchiatti, et al., 2006, p.132.

<sup>75</sup> Kaltenberger, 2009, p.226 and Pérez-Arantegui, et al., 2008, p.1271.

<sup>76</sup> Gratuze, et al., 1996, p.80 ; Pérez-Arantegui, et al, 2008, p.1278 ; Zucchiatti, et al., 2006, p.135.

<sup>77</sup> Zucchiatti, et al., 2006, p.150-151.

<sup>78</sup> Gratuze, et al., 1996, p.80.

<sup>79</sup> **Appendix 9.1** "XRF": p.99, 102-106 and **Appendix 9.3** "SEM-EDS": p.112-131.

<sup>80</sup> Bouquillon, 2019, has made the same observation on 17<sup>th</sup>-18<sup>th</sup> century European glazed ceramics, with no explanation for the presence of arsenic.

Colomban, et al., 2023 analyzed arsenic in Qing porcelain glazes, and linked it to use as a mild opacifier, creating bubbles in red glazes to increase their vibrancy.

<sup>81</sup> **Appendix 9.1** "XRF": p.99 and 104, **Appendix 9.2** "Raman spectroscopy": p.108 and 110. and **Appendix 9.3** "SEM-EDS": p.121-126.

<sup>82</sup> **Appendix 9.1** "XRF": p.99 and 105 and **Appendix 9.3** "SEM-EDS": p.117-120.

<sup>83</sup> Taylor and Bull, 1986, p.45.

<sup>84</sup> **Appendix 9.1** "XRF": p.99 and 102-103 and **Appendix 9.3** "SEM-EDS": p.127-130.

A recapitulative table of glaze colorants found and their common addition percentage can be found below <sup>85</sup>.

<b>Metallic oxide</b>	<b>Common % addition</b>	<b>Chemical compositions</b>	<b>Color</b>
<b>Iron</b>	1 – 10%	Iron oxides, iron hydroxides	Yellow to red-brown. Sometimes greenish.
<b>Copper</b>	0,5 – 8%	Cupric oxide, copper carbonate	Red in reducing atmospheres Green to blue
<b>Cobalt</b>	0,5 – 1%	Cobalt oxide, carbonate, sulfate or smalt (zaffre)	Blue

*Table 1: Colorants used for ceramic glazes and their common addition percentage*

With the research done on the fragments, it is impossible to tell how the colors were applied. They could have been mixed with a frit glaze. Then each colored glaze would have been individually painted on the ceramic body. A transparent glaze could also have been applied and the metal oxides painted on top before firing. A SEM-EDS imaging and mapping on a cross section could allow to identify this, but would require invasive and possibly destructive sampling.

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<sup>85</sup> Taylor and Bull, 1986, p.46.

## Part 3: Diagnostic study

### 3.1 Condition report summary

The condition reports for each object studied can be found in the appendix, p.132-141. As they all exhibit similar alterations, to varying degrees of severity, a summary of the reports is done here.

#### 3.1.1 *Physical alterations*

##### **Structural alterations**

All of the objects are broken. **Breaks** often occurred on fragile areas, such as between the walls and the base (7216, 7217) or areas where elements were adhered together before firing. The break edges are generally jagged, but not very eroded, apart from a few exceptions. On the edges of the breaks, the glaze has often partially flaked off, because it is not fully fused to the ceramic body (**Fig. 32**).

All the objects are lacunary, with the vessel 7216 being the most complete, at an approximated 70%. Most of its missing elements are from its base. **Glaze lacunae** and **surface lacunae** are linked to poor glaze adhesion during fabrication, breaks, or impacts during use and burial. One can recognize the first occurrence because of the rounded edges of the lacunae (**Fig. 31**).



**Figure 31:** *Glaze lacunae occurred during fabrication - 7219*



**Figure 32:** *Glaze and surface lacuna because of breaking*

Finally, on the two objects with figurative appliques, one can observe **separation** between the imprinted figurative motifs and the vessel walls, on the break edges (**Fig. 33**).




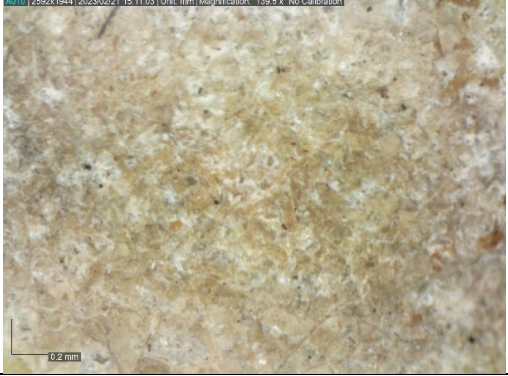





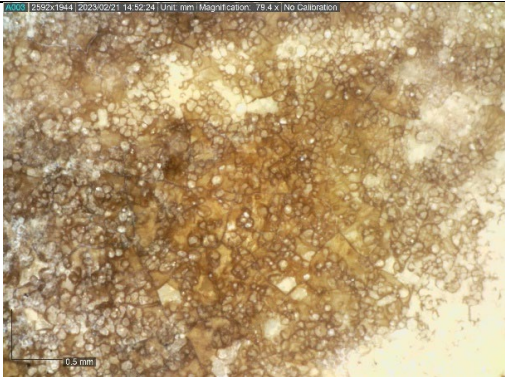

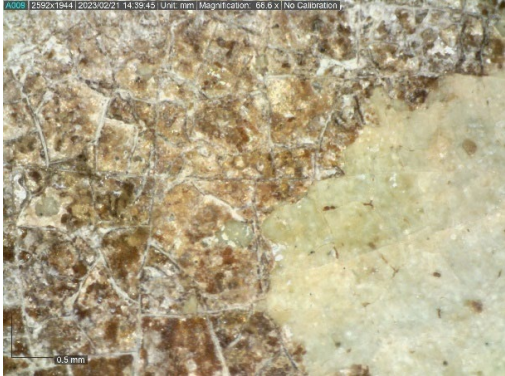

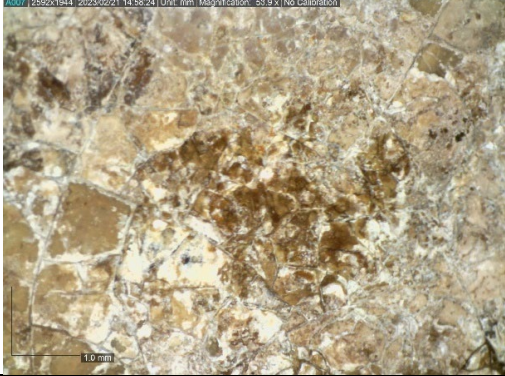

**Figure 33:** *Separation between the imprinted motif and the underlying layer*

## Surface alterations

Because of use and burial conditions, the glazed surfaces have some **micro-scratches** and **abrasions**, causing apparent dullness to the otherwise shiny surface. This is especially the case on rims and protuberant edges.

There are three main types of **deposits** on all of the objects, which are documented in the table below.

<b>Deposits – type 1</b>		
		
		<p><b>Beige or greyish, thicker sandy deposit.</b> It often overlays the brown deposit described above. It is most of the time quite adherent and coherent, while it sometimes flakes off the surface. It is only found in the sunken-in parts of the objects.</p>
<b>Deposits – type 2</b>		<p><b>Grains of dirt or sand</b> in the deep undercuts. They are not adherent to the surface or cohesive, but quite hard.</p>

<b>Deposits – type 3</b>		
		
		
		<p><b>Thin brown deposit</b>, which has in some places penetrated in the crazing of the glaze. It is mostly situated in the sunken-in parts of the decors, and the inner side of the objects. It is quite adherent, but breaks up in dust or little flakes when scraped with a scalpel. This deposit is sometimes cracked and can contain small specks of sand.</p>

**Table 2:** Documentation of the three types of deposits found on the objects

These deposits all originate from the burial context and have an archaeological value, as they document the soil conditions. It has been assessed through microscopic observations that the deposits' nature does not vary significantly from one area of the objects to another, meaning no deposits related to the use of the objects before burial can be identified.

### 3.1.2 Chemical alterations

#### Glaze alterations

The glazes on objects 7216 and 7217 are more significantly altered than on the three other objects (**Fig. 34 and 35**), with some areas especially cracked and flaking off. As this is uniformly the case on all fragments, and that both objects are of the same manufacture, one can safely assume that this more significant degradation is linked to composition and fabrication techniques of the glazes.

The glazes all exhibit **crazing**, to varying extents depending on the object and the color<sup>86</sup>. On objects 7216 and 7217, the dark blue glaze is significantly degraded, with large gaps letting the ceramic paste appear underneath. It appears blistered and is flaking off in some areas. The presence of **bubbles** and **pinholes\*** (**Fig. 36**) has been observed, especially in the blue glazes on 7216, 7217 and 7220.

Finally, we can assess that the glazes have been **lixiviated\*** and **corroded** by their burial environment. Visually, this process appears as **dullness** of the surface, **iridescence\*** (**Fig. 37**), formation of **surface crusts (Fig. 38) or pits, flaking and cracking**<sup>87</sup>.



**Figure 34:** Degraded glaze on object 7216 © Scherrer, HKB

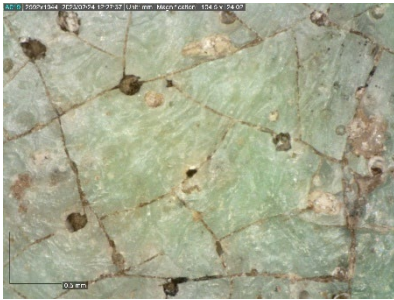


**Figure 35:** Glaze in good condition on object 7218

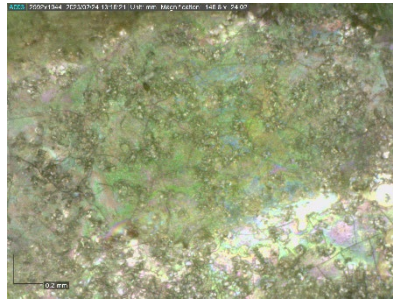
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<sup>86</sup> Magnified photographic documentation of the glaze colors on each object can be found in the **Appendix 10** "Complete condition reports": p.134, 136, 139 and 141.

<sup>87</sup> Taylor and Bull, 1986, p.167 ; Davison, 2003, p.184.



**Figure 36:** Pinholes and crazing in the light blue glaze - 7216



**Figure 37:** Iridescence on the green glaze - 7219



**Figure 38:** Crusts surrounding the crazing lines - 7216

### Soluble salts

No visible signs of the presence of soluble salts\* (efflorescence, flaking, etc.) could be observed on the objects. This is significant for the last 20 years of storage in 45-60% RH. Nevertheless, a test was carried out to assess the presence of nitrates, chlorides and sulfates with semi-quantitative test-strips.



**Figure 39:** The samples immersed in water

The samples were first placed in a humidity chamber for 24 hours to allow the salts to hydrate and be more prone to leaching out in the second phase of the test. Then, they were placed in baths of demineralized water for 72 hours, in clean glass jars (**Fig. 39**). Nitrates were found in small quantities in all sherds (**Table 3**). A risk assessment of this finding will be presented in the Diagnosis, p.31.

Sample	Chloride (Cl <sup>-</sup> )	Nitrate (NO <sub>3</sub> <sup>2-</sup> )	Sulfate (SO <sub>4</sub> <sup>2-</sup> )
<b>Demineralized water</b>	0-500 mg/l	0-0,5 mg/l	<200 mg/l
<b>7216</b>	0-500 mg/l	5-10 mg/l	<200 mg/l
<b>7217</b>	0-500 mg/l	10-25 mg/l	<200 mg/l
<b>7220</b>	0-500 mg/l	10-25 mg/l	<200 mg/l

**Table 3:** Results of the soluble salts test

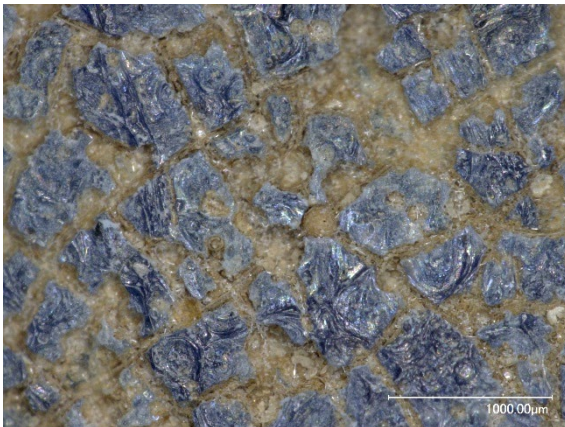
## 3.2 Diagnosis

### Manufacturing defects

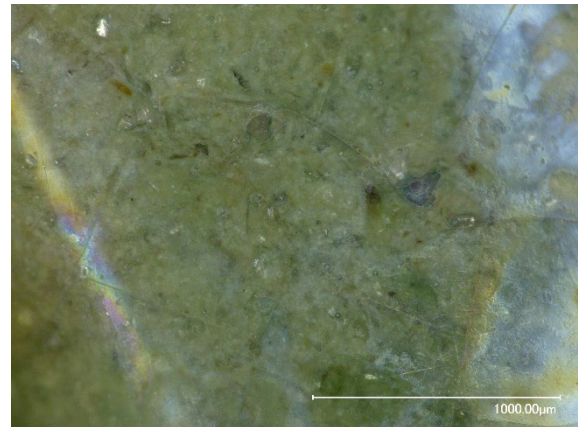
Manufacturing defects can create tensions in the glaze and body and condition the future chemical degradations.

The separation between the inner vessel walls and the imprinted appliques gives us information about the fabrication technique, and most likely occurred during drying. The clay of these elements contained different and inhomogeneous amounts of water, which resulted in a differential evaporation rates, tensions and the separation into layers. Areas of assembly between raw clay elements are particularly fragile, which is why for example the walls of object 7216 have broken off from the base.

Secondly, glaze lacunae, bubbles and pinholes can be linked to a too coarsely ground glaze<sup>88</sup> or to the presence of certain impurities<sup>89</sup>. These areas then serve as preferential starting points for leaching and corrosion<sup>90</sup>. The presence of many bubbles in the dark blue glaze on objects 7216 and 7217 could explain their poor state now (**Fig. 40 and 41**).



**Figure 40:** Highly degraded dark blue glaze on object 7216, with many pinholes, bubbles and irregular surface



**Figure 41:** Green glaze on object 7216, in relatively good condition, with a smooth and bubble-free surface

Finally, glaze defects are linked to the glaze and body thermal expansivity correlation. When they are not compatible, tensions appear (**Fig. 42**). If the glaze has a thermal expansion higher than the one of its substrate, crazing will occur<sup>91</sup>. Crazing is characterized by a network of fine cracks, from the glaze-body interface to the surface of the glaze. Crazing can be instant (after firing) or delayed,

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<sup>88</sup> Kaltenberger, 2009, p.234.

<sup>89</sup> See "Opaque glaze" in chapter 2.1.2, p.13.

<sup>90</sup> Kolarova, et al., 2023, p.22.

<sup>91</sup> Berducou, 1990, p.87.

because of moisture expansion of the substrate<sup>92</sup>, during use or burial. If the glaze contracts less than the ceramic body, the coating will bulge up, lose adhesion to the substrate and eventually flake off<sup>93</sup>. It is very difficult to determine whether the crazing has appeared after firing or after being used and buried, without dilatometric measurements and thermogravimetry<sup>94</sup>, which are invasive measuring techniques to evaluate the glaze fit.



*Figure 42: Glaze crazing and flaking processes*

### **Use, disposal and burial environment**

The burial process, and piling up of soil over the objects can be quite violent, and cause some breaks. Typically, star shaped breaks on circular elements can be correlated to the pressure of the soil. It is also possible that the objects were previously broken by their users, which is why they would have been thrown away in the first place. The abrasions are most likely caused by both use and burial.

The soil environment can have various harmful chemical effects on objects, because of fluctuating conservation parameters such as inappropriate humidity and temperature values – causing delayed crazing of the glazes – and because of the presence of organic and inorganic agents such as pollutants and micro-organisms, that can change the soil's pH and contribute to chemical alterations<sup>95</sup>. Waste pits in particular can contain especially corrosive and chelating\* substances<sup>96</sup>.

During burial, the humid soil accumulates on the objects' surfaces and can penetrate defects, such as the crazing, and porous substrates. Nitrates were found in the ceramics, which are generally linked to the decay of organic material<sup>97</sup>. We would have expected more soluble salts to be present yet very little amounts were absorbed. This is probably linked to the nature of the soil, or the low porosity of the paste and its non-communicating pores<sup>98</sup>. Also, the objects were washed when they came out of the excavation, which could have removed some salts already. The small amount of nitrates are no risk to the long-term conservation of the objects.

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<sup>92</sup> Taylor and Bull, 1986, p.212 and Colombari, 2021, p.10.

<sup>93</sup> Berducou, 1990, p.87.

<sup>94</sup> Kolarova, et al., 2023, p.9.

<sup>95</sup> Kolarova, et al., 2023, p.1-2.

<sup>96</sup> Davison, 2003, p.182.

<sup>97</sup> Freedland, 1999, p.11.

<sup>98</sup> López-Arce, et al., 2013, p.16.

## Lixiviation and corrosion

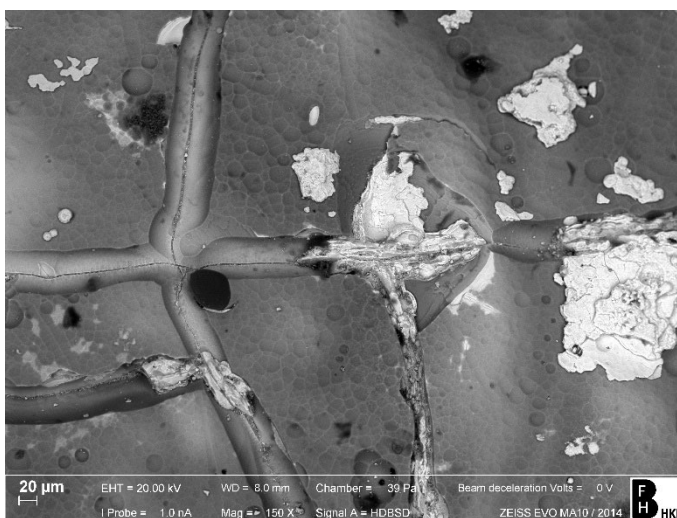
The water in the soil causes leaching of certain components of the glazes. After that, corrosion can occur through network dissolution and recombination of the leached components with elements from the soil.

The first chemical degradation process to occur is the lixiviation of the alkaline (Pb) ions from the glaze<sup>99</sup>. The alkalis from the glassy network are removed and replaced by smaller hydrogen protons, coming from the water<sup>100</sup>. This makes the surface more porous, and sometimes leads to cracking<sup>101</sup>, but it also progressively creates a "silica gel" surface film, which acts as a barrier for further reaction and decreases the ions' diffusion rate<sup>102</sup>.

However, if the environment is acidic – as is often the case in pit environments – lead (Pb<sup>2+</sup>) and silica can be further dissolved<sup>103</sup>. Pits, cracks and depletions from the edges of previously disrupted areas can develop. Local electrolytes\* can form specifically in these fragile zones, where the glaze matrix is dissolved<sup>104</sup>.

Some secondary precipitation products are then formed from the recombination of lead or silicate with an acid from the soil (i.e. lead nitrate, carbonates, sulphates or phosphates<sup>105</sup>). Indeed, on object 7216, lead, phosphate and calcium have been measured in significant amounts in degraded areas, with SEM-EDS<sup>106</sup>. The crusts formed first in cracks and pinholes

(**Fig. 43**), then spreading over the surface of the glaze might be calcium phosphate and lead (II) phosphate.



**Figure 43:** Corrosion crusts formed in and around the cracks of the yellow glaze on object 7216 – SEM imaging, 150x magnification.  
© Scherrer, HKB

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<sup>99</sup> Colomban, 2021, p.12 ; Kolarova, et al., 2023, p.9 ; Domenech-Carbò, et al, 1998, p.103.

<sup>100</sup> Domenech-Carbò, et al. 1998, p.103.

<sup>101</sup> Davison, 2003, p.175.

<sup>102</sup> Taylor and Bull, 1986, p.168 ; Kolarova, et al., 2021, p.420.

<sup>103</sup> Kolarova, et al., 2021, p.420 and 424.

<sup>104</sup> Kolarova, et al., 2021, p.423.

<sup>105</sup> Colomban, 2021, p.12.

<sup>106</sup> **Appendix 9.3** "SEM-EDS": p.115.

The fact that some vessels are significantly and homogeneously more degraded than others means it is linked to fabrication rather than burial conditions. The concentration of silica is essential, as if it is under 62-66% mol., the glaze is more prone to leaching<sup>107</sup>. This is also the case if the percentage of alkalis is too high. However, the presence of low solubility components such as alumina, phosphorous or iron can increase the glaze's resistance to dissolution, by acting as immobilizers for the alkalis<sup>108</sup>.

Colorants are generally present in such small amounts (>1% mol.), that they do not have a direct impact on the chemical stability of a glaze<sup>109</sup>. The presence of a higher amount of defects (bubbles) in the dark blue glaze, due to a too coarse pigment is the most likely explanation for its state of extreme deterioration.

### **Excavation and storage**

During excavation, as there was not enough time for a complete search, there might have been some fragments left behind on site. We can also not exclude the hypothesis that some fragments might be in the museum's possession, but improperly sorted in other storage boxes from the many ceramic finds of the site.

After the excavation, archeological objects are generally washed with water and scrubbed with brushes by the archaeologists, before being dried and transported to the museum storage. Since 1994, the objects have not been treated by a conservator-restorer, and have been stored in museum storage rooms, in a stable climatic environment. Poorly soluble or hard to reach deposits have dried on the ceramic surfaces, sometimes settling in the crazing and becoming extremely hard and adherent.

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<sup>107</sup> Davison, 2003, p.177.

<sup>108</sup> Davison, 2003, p.177.

<sup>109</sup> Davison, 2003, p.178.

### **3.3 Prognosis**

One can safely assume that the objects will not considerably degrade further if they are kept in their current state. The soluble salts do not seem to present a conservation risk. The sherds might get dissociated from one another over time. Also, with repetitive manipulation, the degraded dark blue glaze on objects 7216 and 7217 could progressively lose more flakes.

The degradations of the objects – namely the fragmentation of the vessels – are an issue because it is difficult to read the archaeological profiles and understand the object's previous look and function. Therefore it is impossible to document and to share the objects' shape and look to the general public, and to other archaeologists and historians.

#### **Impact of the alterations on the cultural values**

Because of the alterations, the objects have a limited patrimonial and didactic value, as they are hardly presentable and understandable in their fragmentary state. The fact that the objects are not conserved make them inoperable for display in the museum. The sharing of information is limited by the fact that the objects are not clearly understandable.

The lacunae are an issue in terms of comprehension, but also for stability reasons, if the sherds were to be re-assembled, they would risk breaking again during storage or manipulation, because of undercuts and lack of sufficient contact between sherds.

The deposits and the fragmentary and lacunary state also greatly limit the aesthetics of the objects, which cannot fully be appreciated.

Conservation of these objects would infirm the interest that we have towards them, and highlight their values, that the degraded state does not allow to be exhibited <sup>110</sup>.

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<sup>110</sup> Guillemard, 1998, p.6.

## Part 4: Conservation treatments

### 4.1 Intervention proposal

#### 4.1.1 *Treatment objectives*

The conservation interventions aim to stabilize the objects and allow for them to be easily studied, manipulated, stored and exhibited. One should be able to appreciate the objects for their past function, history and aesthetic. Gap-filling is only done on objects that are sufficiently complete already, as we should not interpret what is missing. Therefore, all sherds will be cleaned, the glaze re-adhered if necessary and glued together. Only object 7216 will be subject to gap-filling, as it is estimated to be more than 65% complete.

The interventions should use materials that are the safe and appropriate for the objects and the conservator, available in Austria, generally commercially available in the largest geographical area possible, and the most budget-friendly possible.

#### 4.1.2 *Cleaning*

The cleaning allows to reduce the visual impact of the residual soil deposits, and to better appreciate the colors of the glazes.

##### **Nature of the soil**

The soiling seems to be of the same nature on all the objects. It is moderately water-soluble and moderately to strongly adherent to the surface. It carries some archaeological value, as it is material proof of the burial context. Conserving this aspect is not a priority, as there are many other ceramics from this context in storage. It also is not representative of the prior use of the objects<sup>111</sup>.

##### **Cleaning options**

Dry ceramic objects should generally not be made very wet for cleaning purposes, as it can make the ceramic body expand, and cause further degradation. Aggressive or uncontrolled mechanical cleaning techniques can cause scratches or flake off degraded and poorly adhesive glaze. Any chemical that requires intensive amounts of rinsing or that leaves an unknown amount of residues should be

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<sup>111</sup> See "Surface alterations" in chapter 3.1.1, p.26-27.

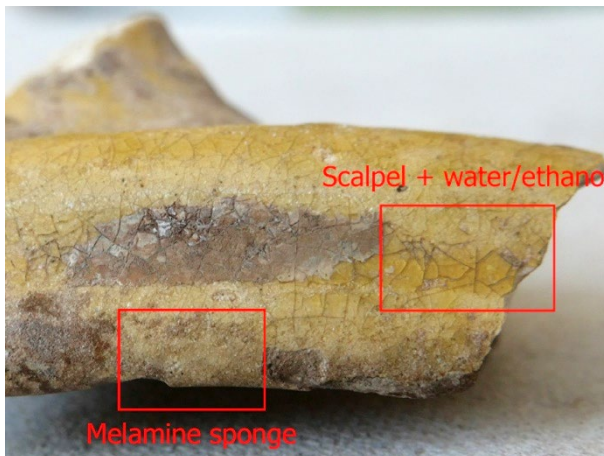
avoided if it is not necessary, as they are often non selective and can leach out constitutive materials from the objects <sup>112</sup>, and induce the addition of a lot of water to the materials.

Appropriate dry cleaning options include careful use of metallic tools such as a scalpel or a needle, and abrasive sponges or erasers. For chemical cleaning, demineralized water is often a great solubilizer, is readily available and safe for the user. It can be mixed with ethanol, so it evaporates faster and has a lower surface tension. The ethanol generally does not play a role in the solubilization.

Since the deposits are not very soluble, different cleaning methods combining mechanical and aqueous action were tested, and are presented in the appendix, p.142. Steam cleaning could have been very effective and quick, and does not over-wet the objects <sup>113</sup>. Unfortunately, it necessitates equipment which is unavailable in the conservation lab.

### **Cleaning protocol**

For thick, flaking deposits, a scalpel can be used to lift them off of the surface. This has to be done under magnification, to make sure no scratches are made on the surface. Cotton swabs slightly wetted with a hydroalcoholic mixture <sup>114</sup> can be used to soften the deposits, and increase contrast and visibility of the area.



**Figure 44:** Results of the successful cleaning tests

For thinner, more adherent soiling, a slightly wet melamine\* sponge <sup>115</sup>, with demineralized water can be gently rubbed on the surface. It has previously been verified with a video-microscope that the melamine sponge does not create micro-scratches on the glaze.

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<sup>112</sup> Berducou, 1990, p.101.

<sup>113</sup> Acton and Smith, 2003, p.49.

<sup>114</sup> 50% of ethanol in demineralized water was used.

<sup>115</sup> Method inspired by Vuillermoz, 2021, p.165.

### 4.1.3 *Glaze re-adhesion*

In some areas, the glaze is not properly adhering to the ceramic substrate, creating a risk of flaking and loss. This could be a problem with further interventions and manipulation as well. This is especially the case with the dark blue glaze on object 7216 and 7217. The goal is therefore to maintain the glaze flakes on the surface, by infiltrating an adhesive at the glaze-body interface. This should ideally happen without change to the color and shine of the surface, and without deep penetration into the ceramic body. Penetration would induce localized consolidation, which is unnecessary and hardly reversible. The adhesive chosen should also have an optimal ageing – minimal color change, good adhesiveness and chemical stability.

Paraloid® B-72 was chosen, because of its good results in ageing tests<sup>116</sup>. It is a copolymer of ethyl methacrylate and methyl acrylate with a 70/30 ratio. It also contains 2% of butyl methacrylate<sup>117</sup>. The size of its macromolecules<sup>118</sup>, and its dissolution in a low polarity solvent<sup>119</sup> insured it would not be significantly absorbed by the substrate. It was also tested against other common adhesives for glaze re-adhesion by Louise Vuillermoz, and showed the best results for its optical and mechanical properties, low penetration and non-reactivity to temperature and HR changes<sup>120</sup>.

The adhesive should be used at a concentration of 10%<sup>121</sup> in ethyl acetate. It can be applied with a thin brush, until the gap is saturated.

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<sup>116</sup> See chapter 4.1.4: "Bonding of the fragments", p.38-39.

<sup>117</sup> Vinçotte, et al., 2009, p.2.

<sup>118</sup> Vuillermoz, 2021, p.115.

<sup>119</sup> Ethyl acetate has a relative polarity of 0,228 compared to 0,355 for acetone, 0,654 for ethanol and 1 for water. According to Frontier, 2023 [online].

<sup>120</sup> Vuillermoz, 2021, p.144-146.

<sup>121</sup> Acton and Smith, 2003, p.57.

#### **4.1.4 Bonding of the sherds**

##### **Choice of adhesive**

The ideal adhesive should be colorless, have minimal shrinkage when drying, long term stability (retain adhesiveness, not become brittle or discolor), and reversibility<sup>122</sup>. It should not penetrate the porosity of the object and its strength should match that of the ceramic body, so that any joint failure occurs inside the bond, and not in the material.

Paraloid® is the adhesive chosen for this intervention. It is the same adhesive used for glaze re-adhesion, which is advantageous in terms of unity of intervention and reversibility.

Compared to other types of common adhesives in conservation, acrylics exhibit the lowest intrinsic yellowness and are transparent<sup>123</sup>. They also have the least amount of change in color after artificial ageing<sup>124</sup>, and were proven not to become hard and brittle when ageing, unlike PVAs<sup>125</sup>. Being a thermoplastic resin, bonds done with Paraloid® can be re-adjusted if necessary, by softening them with a heat gun. The adhesive also remains soluble in ketones, esters and some hydrocarbons after ageing. One caveat with Paraloid® is the moderate toxicity of the solvents<sup>126</sup>.

##### **Choice of solvent and solids content**

Solvents in Paraloid® act as plasticizers, weakening the intermolecular attractions between polymer chains, to allow the product to be fluid enough for application<sup>127</sup>. When drying, the adhesive film slightly retracts as the solvent evaporates. Paraloid® B-72 retains a small amount of solvent even after it is fully dry. This depends on the solvent and will influence the adhesive's glass transition temperature\* (Tg). The faster drying and least retained solvents are acetone and ethyl acetate (1% wt. after 100 days)<sup>128</sup>. 1% solvent retention means the theoretical 40°C Tg drops to 34°C<sup>129</sup>. Paraloid® B-44 has a higher Tg, which could be more advantageous for hot weather in un-climatized exhibition spaces, but it is also more brittle and hard.

One could mix B-44 and B-72 together to obtain a mix of the properties of both adhesives, but it is not done in this case, as easy re-adjustability throughout the intervention process was wished. The

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<sup>122</sup> Acton and Smith, 2003, p.56.

<sup>123</sup> Carbo and Castrò, 1999, p.121.

<sup>124</sup> Carbo and Castrò, 1999, p.124.

<sup>125</sup> Down, et al., 1996, p.39.

<sup>126</sup> Adler, et al., 2016.

<sup>127</sup> Vinçotte, et al., 2009, p.8.

<sup>128</sup> Vinçotte, et al., 2009, p.3 and 5.

<sup>129</sup> Vinçotte, et al., 2009, p.6.

solvent chosen is ethyl acetate, as acetone evaporates so fast it creates large bubbles of adhesive, making it difficult to obtain a thin homogenous bond.

The solids content influences ease of spread, working time and bond thickness. An adhesive which is too fluid might penetrate and create poorly reversible stains<sup>130</sup> and an unsatisfying bond because of important shrinkage. A too thick joint might result in fragment displacement and misalignment<sup>131</sup>. A concentration situated between 40 and 50% of adhesive would be appropriate in this context.

### **Bonding protocol**

Paraloid® B72 at 45% (w/v) in ethyl acetate should be used. Since this equals a large amount of polymer in solvent, shrinkage is minimal during evaporation, and the viscosity makes it optimal for application on a low porosity ceramic.

The adhesive is applied evenly on the break edges, previously dried and cleaned with acetone to avoid any greasy residue<sup>132</sup>. It is applied from a soft plastic bottle with a thin tip. The fragments are assembled and even pressure is applied, to squeeze out the excess adhesive and create a thin joint. The fragments should then be balanced in a sand box, with the break lines parallel to the ground. For complex shapes or larger fragments, removable tape can be added, perpendicular to the break line. After it reaches a gummy consistency, the excess adhesive can be removed with a pointy wooden stick or carefully with a scalpel.

The adhesion of fragments is done in two steps. A first gluing of sherds is made after cleaning, by being careful not to leave gaps with undercuts (angles less than 90°, see **Fig. 45**). This is done in a way that allows the detachable fills to be created without needing to disassemble earlier bonds. After the gap-fills are created, the whole vessel can finally be glued together with its fills.



*Figure 45: Example of an undercut between fragments*

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<sup>130</sup> Acton and Smith, 2003, p.54-55.

<sup>131</sup> Carbo and Castrò, 1999, p.115.

<sup>132</sup> Koob, 1986, p.12.

#### 4.1.5 *Gap-filling and retouching – theoretical framework*

##### **Ethical considerations of gap-filling**

Lacunae in an object represent a part of its history – burial, disposal, or any other past event. This part of history can be complex or unknown, but should be preserved and seen by researchers and the public alike<sup>133</sup>. Nevertheless, lacunae have a visual impact. They can interrupt the figurative fabric or disturb the understanding of the previous use and shape of the object<sup>134</sup>. Creating a visual rupture, the lacuna comes to the forefront and constitutes a sort of visual foreign body that catches the eye<sup>135</sup>.

Gap-filling has three roles : improving conservation (structural fills), improving comprehension, and improving appearance<sup>136</sup>. These roles often overlap in practice, but can be useful decision-making tools.

In the case of gap-filling of archaeological objects, it is extremely important for the interventions to be perceptible – without scientific examination<sup>137</sup> – and understandable. For the ICOM\*, accessibility to the public is a large preoccupation for museums. It is therefore important to make objects understandable to all publics<sup>138</sup>. This should be done through the objects but also through mediation, which is outside the scope of this work.

Two studies on the public's comprehension of restored ceramic objects have been carried out in French museums, and have come to the following conclusions:

- Objects with no fills are sometimes not understood, often overlooked or disregarded. Incomplete objects are somewhat not regarded as beautiful<sup>139</sup>;
- Partial gap-fills (often fills with an only structural role) are misunderstood and disliked by the general public and museum professionals alike<sup>140</sup>;
- Very visible gap-fills (very different or completely uniform color) are often misunderstood and generally disliked<sup>141</sup>;
- Illusionism\* is misunderstood, people can believe the object is intact<sup>142</sup>;
- Children generally have trouble understanding degraded and restored objects<sup>143</sup>;

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<sup>133</sup> Alami-Vigué, 2015 [online].

<sup>134</sup> Guillemard, 1998, p.6 and Bouyer, 2010, in Bulletin de l'APROA-BRK, p.10.

<sup>135</sup> Brandi, 1963, p.42.

<sup>136</sup> Bouyer, 2010, in EGG [online].

<sup>137</sup> Bouyer, 2010, in EGG [online].

<sup>138</sup> L'Hostis, 2007, p.12.

<sup>139</sup> Païn, 2002, p.303-305. **Note:** this study was not specifically done regarding archaeological collections.

<sup>140</sup> Païn, 2002, p.303 and 307.

<sup>141</sup> L'Hostis, 2007, p.12 and Païn, 2002, p.302.

<sup>142</sup> Païn, 2002, p.301.

- Gap-fills on objects with more than 40-50% lacunae are sometimes considered too extensive <sup>144</sup>;
- People understand and appreciate discreet yet visible reintegration <sup>145</sup>.

These observations do not mean we should disregard our codes of ethics, but maybe that we should realize that conservation choices are subjective and that we are subject to thinking in a professional microcosm, sometimes forgetting to consider the recipients of the cultural heritage we conserve <sup>146</sup>. Therefore, the choice of discreet and somewhat extensive gap-fills should absolutely still consider the principles of reversibility and legibility <sup>147</sup>. Also, restitutions must stop where hypothesis begins <sup>148</sup>.

The goal in our case is not to hide the lacunae with illusionist restoration, but to make them fade into the background, letting the viewer first see the unity of the object, then to understand its lacunary state in a second stage <sup>149</sup>. This is the choice that has been done for this object, as it might be used for didactic and exhibition reasons.

### **Technical considerations**

Fills in archaeological objects are almost always made visible <sup>150</sup>. In order to do this, different strategies can be used. First, a technique coming from mosaics and wall paintings is to create a recessed fill, deeper than the original surface or an incision line. This tends to create shadows and has not been retained as an option for the object.

Then, one can play on differentiation of surface finish, by making a matte fill on a shiny object, or a smooth fill near a rugged surface. The fill can also be differentiated chromatically in many ways, including using a lower degree of saturation, or a lighter color, the *puntinato* (pointillism) technique, a predominant color (solid color, often the color of the ceramic body), a medium tone, or an achromatic retouching (shades of grey and white) <sup>151</sup>. The patterns can be completely copied, stylized or not reconstituted.

One can also choose not to do anything to the object and work with lighting, positioning and illustrations in the showcases to make the lacunae less visually disturbing <sup>152</sup>. Supports can also be

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<sup>143</sup> Païn, 2002, p.312.

<sup>144</sup> Païn, 2002, p.303.

<sup>145</sup> L'Hostis, 2007, p.12 and Païn, 2002, p.312.

<sup>146</sup> Païn, 2002, p.313.

<sup>147</sup> Berducou, 2001, p.216.

<sup>148</sup> Fontaine-Hodiamont, 2012, p.14, according to the Venice Charter.

<sup>149</sup> Berducou, 2001, p.216.

<sup>150</sup> Cleeren, 2005, p.71.

<sup>151</sup> Bouyer, 2016, p.77-78.

<sup>152</sup> Fontaine-Hodiamont, 2012, p.8.

created, out of metal bars, epoxy casts<sup>153</sup>, Plexiglas®, or more recently 3D printed polymers<sup>154</sup>. These are especially interesting for objects with extensive lacunae, to fill empty spaces and position them in their functional position, without maximal intervention. Virtual reconstructions are also possible but very costly. Also, we should not seek to replace all real objects by virtual ones<sup>155</sup>.

### **Extent of intervention**

When we speak of lacunae in this document, it is referring to missing sherds. There are other lacunae which are wear and tear, intentional holes, shards, cracks and break lines<sup>156</sup>. All of these will not be treated in the gap-filling interventions, as it is not necessary structurally or aesthetically – for an already degraded and heterogeneous-looking archaeological object. It is not necessary either for the legibility of the figurative decors, as they are repetitive and not extremely detailed.

The gap-fills will be conceived as **detachable**. This means the fills will be created with an isolation layer between the filling material and the fragment. They will then be worked and finished separately from the object, thus avoiding the risks of scratches, abrasions and incrusting dust into the surfaces. The gap-fills will have a **smooth** surface and be **level** with the original. Finally, they will be glued to the object like another sherd. The legibility will be possible thanks to the **retouching technique** and the **mat surface finish**.

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<sup>153</sup> Bergeron (dir.), 2007.

<sup>154</sup> Online Conference videos on the subject can be found on the International Mountmakers Forum website: <https://www.mountmakersforum.net/computer-modeling>

<sup>155</sup> Cleeren, 2005, p.72.

<sup>156</sup> Bouyer, 2010, *in* APROA-BRK, p.9-10.

## **4.1.6 Exploration of the use and creation of detachable gap-fills for an apertured vessel**

### **4.1.6.1 Materials and techniques**

Detailed recapitulation of all tests carried out before arriving to a gap-filling protocol can be found in the appendix, p.143-149. The following sections will present a summary of the determination of the appropriate materials and techniques for gap-filling.

#### **Silicones**

In order to create missing parts of reliefs, an imprint must be created with silicone. Since it must be in direct contact with the object, only room-temperature vulcanizing (RTV) poly-additive\* silicones are appropriate. Poly-condensation\* silicones are forbidden for use on silicate materials, as there is a risk of the silicon forming chemical bonds with the material<sup>157</sup>. Poly-additive curing silicone are generally more durable, cure faster and tend to rip less easily, but they can experience cure-inhibition\* because of contact with many materials, such as amines, sulfurs – from latex and some modelling materials –, etc<sup>158</sup>. They exist in liquid and putty form. Liquids are more precise and can be more supple, but they cannot be applied on vertical surfaces or without some kind of mold box.

The silicon should be able to reproduce fine details without distortion, not damage the object, be compatible with the other materials used in the intervention, and be available at reasonable costs<sup>159</sup>. A satisfying level of detail for our intervention could be obtained by both the liquid and putty silicones tested, but the putty is only appropriate for small areas without undercuts and with a glaze in relatively good condition, as it is more hard – it can rip off some glaze flakes when removed, which was not observed with the liquid silicon.

Oil-like staining has been observed both on a test piece of ceramic and on the object, appearing as a darkening of the surface. This is most likely uncatalyzed low molecular weight silicone, which tends to deposit more when the curing times are long and the viscosity lower<sup>160</sup>. This can be prevented by applying a barrier, but the one available at the museum (Rhenodiv<sup>®</sup>) did not seem to diminish the staining and might introduce another foreign material in the ceramic, of unknown chemical nature (**Fig. 46**). The staining can somewhat be removed by repetitive cleaning with a hydrocarbon solvent<sup>161</sup> (**Fig. 47**). This is why the minimal amount of molds of the object should be created. If

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<sup>157</sup> De Chavagnac, 2006, p.110.

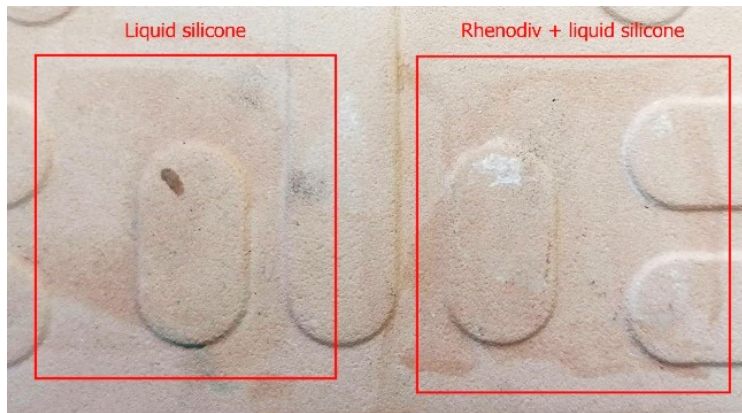
<sup>158</sup> Blanpain, 2012 [online].

<sup>159</sup> Detailed comparative tables of the silicones and dental wax can be found in **Appendix 11.2** "Gap-filling": p.143.

<sup>160</sup> Maish, 1994, p.250 and 252.

<sup>161</sup> In our case, White Spirit 100/140 was used. It is a hydrocarbon with less than 1% aromatics and a boiling point between

possible, dental wax can be used, as it leave no residues. It only works for small, flat or simple imprints.



**Figure 46:** Comparison of the silicone residues with and without a barrier



**Figure 47:** Comparison of the staining, before and after cleaning with White Spirit 100/140

	<b>Putty silicone</b>	<b>Liquid silicone</b>	<b>Dental wax</b>
Commercial name	AWASIL NOVO 50 AWASIL NOVO 50L	WAGNERSIL 32N	Cera reus modeling wax sheets
Technical data	Poly-additive silicone, 1:1 ratio Hardness: 50 Shore A Pink color	Poly-additive silicone, 1:1 ratio Hardness: 32 Shore Blue color	Microcrystalline and paraffin wax Resistant to hot climates Pink color
Price	25,50 Euros/kg	30 Euros/kg	27,8 Euros/kg
Ease of use and versatility			
Precision			
Re-usability of the mold			
Damage to the ceramic			

**Table 4:** Comparison of the tested mold making materials  
 (red = inadequate ; orange = somewhat dissatisfying ; green = adequate)

100 and 140°C.

## Plaster for direct gap-filling and casting

The most common materials for the creation of ceramic gap-fills are plasters. This is thanks to their thermal expansion coefficient and density that are similar to ceramics<sup>162</sup>, as well as their wide-spread availability, low price, and ease and flexibility of use. There exists a great variety of plasters, but they generally mostly contain calcium sulfate semihydrates. Semihydrates can be  $\alpha$  – harder and requiring less water –, or  $\beta$  – softer and requiring more water<sup>163</sup>. A plaster with a higher amount of  $\alpha$ -semihydrate is often wished for conservation purposes.

When mixed with water, the plaster combines with it, slightly expands and heats, before hardening. This makes it ideal for casting in molds, as it will expand into small details, but somewhat risky for direct application on an object. Plaster also tends to adhere mechanically very strongly to porous substrates, which makes de-restoration complicated and hazardous. Finally, the sanding process to finish the fill can scratch the object's surface and infiltrate plaster dust into it. These all make good pleas to prefer detachable fills rather than direct fills, even if the processing is slightly trickier and time-consuming.

Alabaster plaster and Knauff® modelling plaster were tested<sup>164</sup>. In the end, the modeling plaster was preferred because of slightly higher hardness and density, and for its color. The alabaster plaster was a very cold gray color after drying, making the subsequent retouching more difficult (**Fig. 49**).



**Figure 48:** Knauff® modelling plaster, after casting



**Figure 49:** Alabaster plaster, after casting

Tinting the plaster was considered, but it has been decided against it. Advantages would have been that if the fills were to be dented during manipulation, the stark white plaster color would not appear and disturb the unity of the object, and it would create a good base for retouching. But, since a white finishing layer is applied to close the porosity, it would not have been relevant. It is also claimed that tinting the plaster might compromise its structural integrity<sup>165</sup>.

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<sup>162</sup> Gypsum has a density of 2.32 and fired ceramics 2.4-2.6. According to Koob, 1987, p.63.

<sup>163</sup> De Chavagnac, 2006, p.77.

<sup>164</sup> Detailed comparative tables of the plasters tested can be found in **Appendix 11.2** "Gap-filling": p.144.

<sup>165</sup> Koob, 1987, p.63.

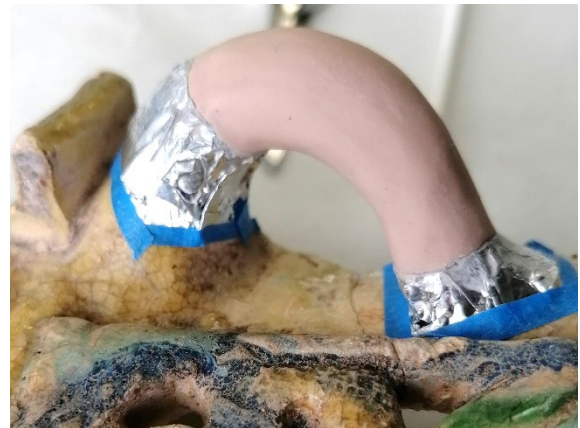
## Modeling materials

Some elements could not be created by casting. This is the case of the handle for example. For these elements, they have to be modelled first, before being molded in silicone, then cast in plaster.

The modeling materials are evaluated on workability, drying, compatibility with silicone, precision of the imprint of the break edges, availability and health and safety. Plasticine, ceramic clay, self-curing clay, and Plastiline® were tested. The plasticine was eliminated quickly, as it was too soft, and contains sulfur which can cause cure inhibition of the silicone and leave residues on the object. The three other materials were used to create a handle by sculpting, and a large gap-fill by pressing the material into a silicone mold<sup>166</sup>. The workability and hardening of the clays were interesting, but the fills were rendered completely useless as they retracted too much upon drying (**Fig. 50**). Plastiline® had the great disadvantage of deforming too easily when very small elements were made, but it never dried and had a good precision and workability. Plastiline® is available in different hardness levels, and a slightly harder one could be purchased for very small or thin fills.



*Figure 50: Handle sculpted out of self-curing clay, after drying. There are gaps because of retraction.*



*Figure 51: Handle sculpted out of Plastiline®*

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<sup>166</sup> Detailed comparative tables of the modeling materials tested and illustrations of the process can be found in **Appendix 11.2 "Gap-filling"**: p.145-146.

	<b>Plastiline®</b>	<b>Clay</b>	<b>Self-curing clay</b>
Drying and retraction			
Hardness and deformation			
Health and safety			
Compatibility with molding material			
Surface texture			
Precision			
Re-usability			

*Table 5: Comparison of the tested modeling materials*

#### **4.1.6.2 Surface finishing and retouching**

##### **Surface finishes**

Although the surfaces of the object are irregular and rough in places, it was decided that the fills would have an overall smooth surface finish, to allow for visible differentiation and because it looks more homogenous. After creating and smoothing the plaster fills, bubbles and imperfections often remain. Therefore, a finishing layer is applied. It can be plaster or a polymer coating. A finishing layer can also make the surface less porous and more scratch resistant.

Plaster, Modostuc® and Paraloid® B-72 were tested. Their impact on surface hardness, color, porosity and paint application was assessed. Both the plaster and the Modostuc® were slightly watered-down and applied with a brush (**Fig. 52**). The Paraloid® was used at 10% in ethyl acetate, and the plaster test piece was bathed in the adhesive until no more bubbles rose to the surface.

Plaster alone was scratched very easily and was extremely porous, making paint application difficult, appearing streaky and dull. The surface finished with Modostuc® could be scratched less easily, and was somewhat non porous. The paints appeared very vibrant on it, maybe partly because it is a very bright white color. With Paraloid®, the surface became very hard and completely non porous, which can be advantages. The paints did not adhere well to the surface, especially the acrylics which could easily be scratched off after drying<sup>167</sup>.

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<sup>167</sup> Detailed comparative tables of the finishing materials tested can be found in **Appendix 11.3** "Retouching": p.147-148.

Modostuc® has therefore the best overall results. It is a coating with a mineral part mixed with a PVA adhesive. It is widely used in conservation and its ageing has been proven to be satisfying <sup>168</sup>.



**Figure 52:** Plaster « copy » after casting (left), after applying Modostuc® (middle), and after sanding the Modostuc® (right)

	Plaster / Moltofil®	Modostuc®	Paraloid® B-72
Surface hardness			
Color			
Porosity			
Oil paint application			
Gamblin® colors application			
Acrylic paint application			
Paint adhesion			

**Table 6:** Comparison of the tested surface finishing materials

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<sup>168</sup> Dehaut, 2013 [online].

## Retouching media

Several medias were tested : water-mixable oil paints, Gamblin® Conservation Colors and Golden® Fluid Acrylics. They were evaluated based on their ease of use, stability and ageing, health and safety and visual effect.

The oil paints were tested because it is what is commonly used at the museum, and by several Austrian archaeological objects conservators<sup>169</sup>. They were quickly eliminated because of practical reasons : their drying time of seven days is a scheduling problem in the case of this work, and the application technique chosen in the end was not compatible, as these paints are more used for very thin consecutive layers of color. Also, the ageing of these paints is not documented, but oil binders generally discolor with time<sup>170</sup>. It is always best to have a homogenous use of conservation materials throughout a collection, but these issues were enough reason to do differently.

The Gamblin® and Golden® paints have a known ageing<sup>171</sup>, which is well documented in literature and depends only on the lightfastness of pigment used<sup>172</sup>. Gamblin® colors are solvent soluble pigments in an aldehyde resin binder which create vibrant, translucent and thin colors. Golden® paints are acrylic emulsions that can be thinned with water, and yield translucent to opaque colors. Both dry quickly and apply easily. Gamblin® colors have the advantage of transparency and thinness, but a layered application is hardly possible because the addition of a new layer in the solvent dissolves the underlying layer. This also makes them slightly more toxic to the user, as dowanol was used<sup>173</sup> to dissolve them.

The choice of retouching media depends on the application technique and the visual effect desired.

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<sup>169</sup> Brosius, 2021 [conference].

<sup>170</sup> Bonaduce, et al., 2012.

<sup>171</sup> Jablonski, et al., 2004 [online] and Dehaut, 2013 [online].

<sup>172</sup> Golden acrylics: Jones, 2004 [online].

Gamblin Conservation colors: de la Rie, et al., 2000.

<sup>173</sup> Propylene glycol monomethyl ether. It was recommended by the painting conservators of the Salzburg Museum because of its appropriate evaporation rate for retouching. Its safety data sheet can be found in the **Appendix 12** "Product data sheets": p.164.

## Retouching technique

Retouching technique allows to blend the gap-fills with the object and make them discreet, yet noticeable. Applying a solid color, a replication of the original colors at a slightly lighter shade, and *puntinato* were tested on plaster “copies” of the figurative applique.

The solid background color (**Fig. 53**)– of the color of the ceramic body – would have made the fills extremely visible, which is not considered appropriate, since this is a very decorative and aesthetic object. Doing color replication with flat swaths (**Fig. 54 and 55**) did not yield particularly convincing results, first because of the inhomogeneity of the plaster surface<sup>174</sup>. Also, the blended and degraded aspect of the glaze colors was difficult to replicate, as Gamblin® colors and the acrylics did not lend themselves well to blending.



**Figure 53:**  
Background color with  
oil paints



**Figure 54:** Replication of the  
colors, with Gamblin® on a  
Modostuc® and plaster base



**Figure 55:** Replication of the  
colors, with Gamblin® on a  
surface finished with Paraloid®

*Puntinato* or pointillism is a technique developed in Italy, where the retouched area is stippled with very small dots. This hazy aspect gives a sort of vibration to the colors, and the multiple colored dots will merge by visual osmosis<sup>175</sup>. It can be done with a paintbrush (**Fig. 56 and 57**) or by projection of paints with a toothbrush (**Fig. 58**). Because of the small size and shapes of the fills, it is more appropriate to color



**Figure 56:**  
Pointillism with  
acrylic paints



**Figure 57:**  
Pointillism with  
Gamblin® colors



**Figure 58:** Pointillism by  
projection, with acrylic paints

them with a thin brush, for more precision. The test copies with the pointillism technique yield the best results and the technique was approved by the museum collaborators in charge of the project.

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<sup>174</sup> It is inevitable after sanding that porous plaster is present in spots, even when the surface was covered in Modostuc®.

<sup>175</sup> Bandini, 2006, p.5.

### 4.1.6.3 Final gap-filling and retouching protocol

Based on the test results, the following protocol has been created.

Filling		
Description of the steps	Materials and tools	Time
<p><b>Silicone imprint:</b></p> <ol style="list-style-type: none"> <li>1. Clean the surface of the object with White Spirit 100/140</li> <li>2. Delimit the mold box edges and fill undercuts with Plastiline®</li> <li>3. Level the object</li> <li>4. Prepare the silicone (1:1) and pour it onto the object</li> <li>5. After curing, remove the mold and clean the object's surface 3 times with White Spirit 100/140</li> </ol>	<p>Plastiline®</p> <p>White Spirit 100/140 and cotton swabs</p> <p>Liquid RTV2 polyaddition silicone</p> <p>Disposable cups and scale</p> <p>Stainless steel mixing tools</p>	6h
<p><b>Detachable fills:</b></p> <ol style="list-style-type: none"> <li>1. Isolate the ceramic edges with aluminum foil</li> <li>2. Assemble the fragments surrounding the gap, using tape, Plastiline® supports or a sand box</li> </ol> <p><b>Plaster gap-fills:</b></p> <ol style="list-style-type: none"> <li>3. Place the silicone mold or dental wax shape onto the object</li> <li>4. Prepare the modeling plaster at 6:10 proportions (water to plaster). Sift the plaster in the water, let it sit for 2 minutes then mix.</li> <li>5. Apply the plaster in the mold with the metal spatula to avoid air bubbles.</li> <li>6. Let harden, then remove the mold.</li> </ol> <p><b>Sculpted elements:</b></p> <ol style="list-style-type: none"> <li>3'. Model and sculpt Plastiline® to create the missing shapes (if necessary heat it with a hair drier to make it more soft)</li> <li>4'. Smooth the surface with fingers and/or a cotton swab with White Spirit and let it "set" for a few hours</li> </ol>	<p>Aluminum foil</p> <p>Removable tape</p> <p>Plastiline® and sandbox</p> <p>Modeling plaster</p> <p>Demineralized water</p> <p>Scale, sift, rubber bowl</p> <p>Flexible metal spatula</p> <p>Plastiline®</p> <p>Hair drier</p> <p>Test-Benzin 100/140</p>	26h
<p><b>Mold and cast the sculpted elements:</b></p> <ol style="list-style-type: none"> <li>1. Create a mold box or use disposable cups</li> <li>2. Create a one or two-part mold of the sculpted element by pouring liquid silicone.</li> <li>3. Once the silicone is cured, remove the sculpted element.</li> <li>4. Cast the plaster in the silicone mold using a 7:10 proportion. It can first be brushed onto the surface or applied with a spatula to avoid air bubbles.</li> <li>5. Remove the plaster cast from the mold. Repeat if necessary or if there are too many bubbles.</li> </ol>	<p>Plastiline®, or disposable cups</p> <p>Liquid RTV2 silicone (polyaddition or polycondensation)</p> <p>Modeling plaster</p> <p>Demineralized water</p> <p>Scale, sift</p> <p>Stainless steel mixing tools and flexible spatula, brush</p>	12h

<p><b>Finish the plaster elements:</b></p> <ol style="list-style-type: none"> <li>1. Remove imperfections with a scalpel and sandpaper. Make sure the surface of the fill is flush with the ceramic surface and adjust if necessary.</li> <li>2. Fill bubbles with Modostuc® applied with a spatula</li> <li>3. Sand the fill surface until smooth</li> <li>4. Finish the plaster elements with a sealant (Modostuc®) diluted with demineralized water and applied with a brush</li> <li>5. After drying for 3 hours, sand again until smooth, with sandpaper and micromesh</li> </ol>	<p>Scalpel  Sandpaper  Micromesh  Modeling Plaster  Modostuc®  Demineralized water  Spatula, brush</p>	<p>60h</p>
<p><b>Adhesion</b></p>		
<ol style="list-style-type: none"> <li>1. Using Paraloid® B-72 at 45% in ethyl acetate, adhere the fragments and the fill together.</li> <li>2. Make sure the elements fit together by assembling the fragments together with tape, in a sandbox, or with a Plastiline® support. Let the glue dry while keeping the break lines parallel to the ground.</li> <li>3. After partial drying, remove the rubber-like adhesive excess with a wooden stick and a scalpel.</li> </ol>	<p>Paraloid® B-72 45% in ethyl acetate in a plastic bottle  Sand box and Plastiline®  Removable tape  Wooden stick  Scalpel</p>	<p>8h</p>
<p><b>Retouching</b></p>		
<ol style="list-style-type: none"> <li>1. The gap-fill surfaces are retouched using the pointillism technique applied with a brush. The colors used are Golden® acrylic paints.</li> </ol>	<p>Golden® acrylic paints  Thin paintbrushes  Water and mixing palette</p>	<p>36h</p>

**Table 7:** Protocol for the second phase of intervention

The times have been estimated for four direct plaster fills and eighteen elements to be sculpted, then copied in plaster. The complete gap-filling and retouching intervention was estimated to take nineteen eight hour work days. In reality, the filling and bonding interventions will not take place in the order presented here, but in sequence, one area at a time. The vessel is progressively re-assembled, facilitating the creation of the next gap-fills. This will be illustrated in chapter 4.2.4.

## 4.2 Conservation interventions

### 4.2.1 *Cleaning*

The cleaning was carried out using several techniques : with a scalpel and a water-ethanol mixture for thick deposits, and with a slightly wet melamine sponge for thinner deposits. This was always done under magnification to ensure the surface was not damaged or scratched. Throughout the cleaning process, it was noticed that the surface under the deposits is often more degraded than the surrounding areas. It is likely that the – possibly acidic – residues continued attacking the glaze during storage.

The inside of the vessels 7216 and 7217 was cleaned less thoroughly (**Fig. 63 and 64**), because of the extreme adherence of the deposits, and to avoid the final results looking uneven and irregular. When necessary, the break edges were picked with a needle to remove soil residues which did not allow for a good joint between the fragments for gluing.



*Figure 59: Sherd from object 7216, before cleaning*



*Figure 60: Sherd from object 7216, after cleaning*



*Figure 61: Sherd from object 7216, before cleaning*



*Figure 62: Sherd from object 7216, after cleaning*



**Figure 63:** Back of a sherd from object 7216, before cleaning



**Figure 64:** Back of a sherd from object 7216, after cleaning



**Figure 65:** Sherd from object 7218, before cleaning



**Figure 66:** Sherd from object 7218, after cleaning

#### **4.2.2 Glaze re-adhesion**

The re-adhesion of the fragile glazes was done in parallel to cleaning, to avoid lifting glaze flakes during mechanical cleaning. Any excess of adhesive can lead to a darkening of the surface, so it had to be carefully avoided, by intervening under magnification.

Paraloid® B-72 at 10% in ethyl acetate was infiltrated at the interface between the glaze and the ceramic body. A fine synthetic paintbrush was dipped in the adhesive and drops of the adhesive were applied into the gaps. When the adhesive stopped penetrating underneath the glaze, the process could be stopped. Any excess was removed with a cotton swab with ethanol.

### 4.2.3 Bonding of the sherds

The objects 7217 to 7220 were glued together following the protocol.



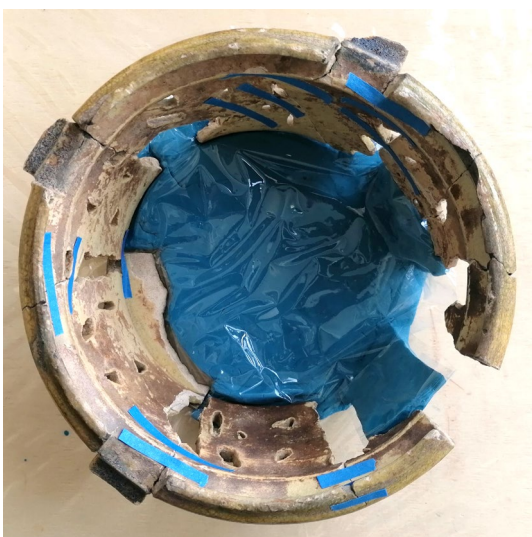
**Figure 67:** Use of a sandbox to hold the sherds during the drying of the adhesive



**Figure 68:** The fragment is balanced in a way that the break line is parallel to the ground.

The fragments of 7216 were glued together in small groups, without undercuts. This allows for the gap-fills to be created and detached from the object without having to disassemble glue joints.

At this point, the vessel was assembled and put on a temporary support made from plasticine (**Fig. 69 and 70**). Photos were taken in order to assess more precisely the extent of the gap-fills that had to be made, and create a reassembly diagram, which will be presented in the next section.



**Figure 69:** Object 7216 seen from above on its temporary support

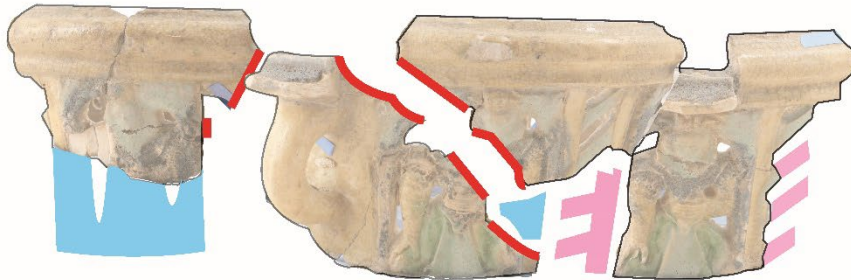


**Figure 70:** Object 7216 on its temporary support

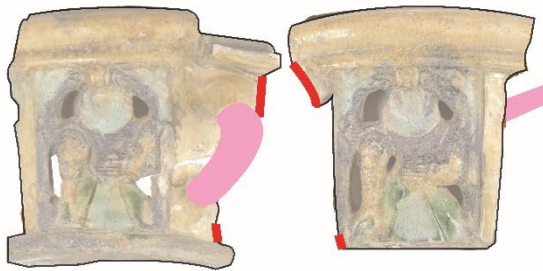
#### 4.2.4 Detachable gap-fills

As was previously presented, some fills could be directly done out of plaster, with the help of a mold. Others first had to be sculpted, before being molded and cast in plaster. The sequence in which the fills could be created had to follow a certain order, so the vessel could be progressively glued, allowing for the next gap-fills to be created. This is illustrated below.

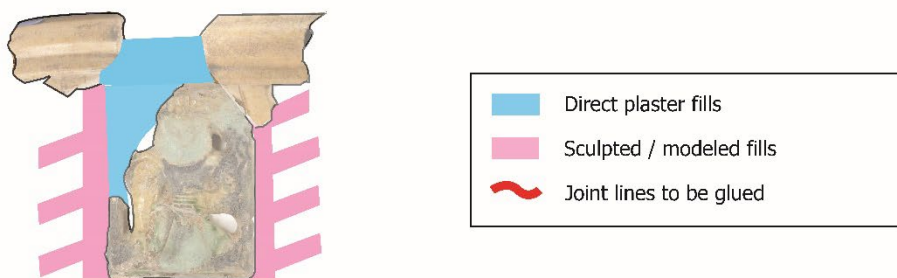
**Step 1:** Create the gap-fills, then glue the fragments and fills together.



**Step 2:** idem



**Step 3:** Assemble the vessel with tape, to have the correct spacing for the edge piece. Then, create the gap-fills and glue together.



**Step 4:** Glue the three groups of fragments together.

**Step 5:** Create a base piece, for the object to stand straight.

*Figure 71: Gap-filling and reassembling diagram*

After the whole object was assembled, a small base could be created. Such a base would allow the object to be stable and straighter when placed in its functional position. It was conceived to be placed underneath a gap-fill, in order to avoid unnecessarily adding material to the original (**Fig. 89**). It was also made as minimal as possible, since the base is extremely lacunary. Creating a complete base for the object would be interpreting the unknown, and might lead to incorrect interpretation.

### Direct plaster fills

A one-part silicone mold of the figurative applique was created, in order to make the plaster fills (**Fig. 72, 73 and 74**). A fragment with the least amount of defects was chosen<sup>176</sup> and the applique molded according to the protocol<sup>177</sup>. This process did not damage the fragile glaze but it did peel off some dirt deposits from cracks and pits.



**Figure 72:** The apertures are filled with Plastiline® and the sherd is levelled



**Figure 73:** A mold box is created with Plastiline® sheets



**Figure 74:** Liquid poly-additive silicone (WAGNERSIL 32N) is poured onto the object

Before the molds could be fixed to the object and filled with plaster, the adjoining ceramic sherds had to be assembled with tape. Then, the edges had to be isolated, in order for the plaster fills to be removable. Aluminum foil was conformed to the break edges with the fingertip and a wooden stick, being careful not to create rips. The foil was maintained by tape when necessary (**Fig. 75**).

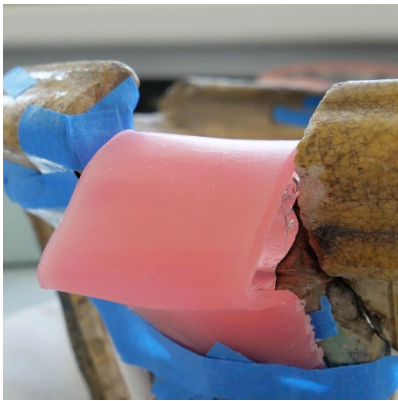


**Figure 75:** Isolation of break edges with aluminum foil

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<sup>176</sup> In reality, one mold was created for the preliminary testing, and a second for the intervention. This is because in between these two phases, analyses were carried out on the sherd we wanted to mold, and the silicon residues might have disrupted the analysis results.

<sup>177</sup> Tips to obtain a good, bubble-free mold can be found in: Blanpain, 2012 [online] ; Kuban, 1991-2015 [online].



For the missing lip, a sheet of dental wax was conformed to the shape of an existing lip (**Fig. 76**). The sheet was first cut to size, then heated with a hair drier in order to be deformed. The piece was then moved over the lacuna and fixed with tape to allow casting of the missing sherd. This created a very imprecise shape in plaster, which had to be reworked a lot, but the cast of the break edges was the most important and came out satisfying.

*Figure 76: Use of a dental wax sheet to cast the missing lip*

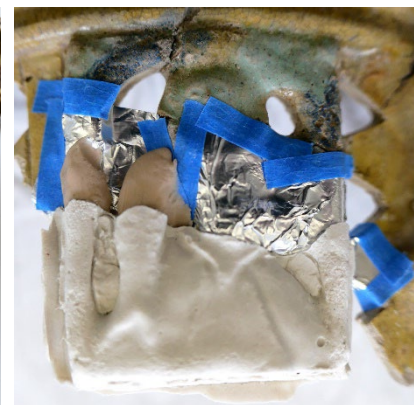
The plaster was prepared according to protocol, in a thick consistency. It was applied with a flexible steel spatula, and pressed onto the break edges and the mold, to avoid bubbles. After a few hours of setting, the fill could be removed. When the plaster is not fully set, it is somewhat easier to shave off the excesses and cut out the apertures with a scalpel. It is then left to dry before further shaping.



*Figure 77: Materials for preparing plaster – rubber mixing bowl, sieve, flexible steel spatula, measuring cup*



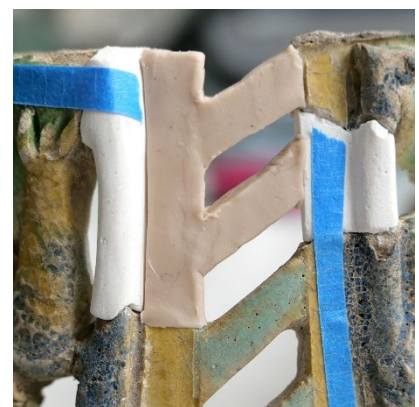
*Figure 78: Application of plaster using the silicone mold against the object*



*Figure 79: Plaster gap-fill, after removing the silicon mold*

### **Sculpting fills**

For the fills that needed to be sculpted, Plastiline® was used, carefully pressed into the break edges and formed using metal tools and fingers. Smoothing with a solvent is possible, but rarely necessary, as the surface imprecisions can be reworked on the plaster copy. The modeled shapes were generally made slightly larger than necessary for this reason.



*Figure 80: Gap-fill sculpted out of Plastiline®*

The fragments could then be disassembled and the sculpted elements removed, with tools and hands as cold as possible and minimal pressure, to avoid deformation. Using a Plastiline® mold box (**Fig. 81**) or disposable cardboard cups (**Fig. 82**), a one-part mold was made of the elements with the liquid silicone. After curing and removing the Plastiline®, plaster copies were made using the molds (**Fig. 85**).



**Figure 81:** *Plastiline® mold box, to mold the base piece*



**Figure 82:** *Pouring silicone (WAGNERSIL 32N) onto Plastiline® pieces, in the bottom of a cardboard cup*



**Figure 83:** *Silicone mold after curing and removing the Plastiline® pieces*



**Figure 84:** *Silicone mold after trimming the excesses with small scissors*



**Figure 85:** *Casting plaster into the silicone mold of the base piece*

## Shaping and finishing the gap-fills

The gap-fills have to be precisely shaped and smoothed, in order to be level with the object's surface. This is done with a scalpel and sand papers, from a granulometry of 400 to 1000. Measuring tools such as a caliper were used to check the progress, then simply placing the fill against the object and marking with a pencil where adjustments should be made. Any small mishaps could be filled with Modostuc®.

Finally, the surface could be finished with a thin layer of watered-down Modostuc®, applied with a brush, and sanded to a granulometry up to 6000 with Micromesh\*.

## Bonding the gap-fills and the object



Once a series of gap-fills is complete, a bigger ensemble of fragments can be bonded together, following the plan presented on page 56. Some adjustments or small gaps between gap-fills had to be made at this point, using Modostuc® (**Fig. 86**). To protect the object during the sanding of these areas, it could either be placed in a position where no dust would fall onto it, or isolated with tape and cellophane.

*Figure 86: Finishing layer of Modostuc® applied between joining gap-fills, to make the transition appear smoother*

The complete gap-filling and bonding process is repeated until the object is in one piece (see **Fig. 87, 88 and 89**).



*Figure 87: Object 7216, after gap-filling and gluing*



*Figure 88: Object 7216, after gap-filling and gluing*



*Figure 89: Object 7216, after gap-filling and gluing*

#### 4.2.6 *Retouching*

The gap-fills were colored in using the *puntinato* technique, with Golden® acrylic paints. The colors used were based on the surrounding colors. On large fills, they were replicated from identical areas on other parts of the object. Generally, one plane of color was composed of three to four different shades of colored dots: two variants of the surface color (i.e. yellow) and one to two "soiling" colors (grey to brown shades).

Since the fills were already glued on the object, particular care was taken in order to avoid applying paint on the original object.



*Figure 90: Detail of the retouching*



*Figure 91: Detail of the retouching – inside of the object*

## 4.3 Preventive conservation measures and recommendations

Ceramic objects are generally not affected by the climatic conditions seen in indoor conservation environments. The conservation interventions, notably the use of a thermoplastic acrylic adhesive, plaster gap-fills and acrylic retouching, have made this object somewhat more sensible to thermohydrimetric conditions than before. The following conservation conditions should be followed to insure its long term preservation.

### Relative humidity (RH) and temperature

A relative humidity between 40 and 60%, with the least frequent and important variations possible is necessary for the good conservation of the object<sup>178</sup>. Important and frequent variations can favor the lixiviation process of the glazes. Above 60%, the acrylic paint of the retouching might lift, and above 65%, the plaster might deteriorate<sup>179</sup>. The addition of liquid water (condensation, cleaning, etc.) is proscribed, as it will damage the gap-fills and if it is long term, the glazes as well.

Rapid temperature variations should be kept at a minimum. Because the glass transition temperature of the adhesive is of 34°C<sup>180</sup>, the storage and exhibition temperature should always be kept under this value.

### Light

Light levels are not a significant risk factor for the objects. The conservation materials have been chosen for their good results in ageing tests. For good measure, UVs should be kept at a minimum to avoid any possible yellowing of the adhesive or the retouching. In exhibits, close-up lighting that produces important heat should be avoided.

### Manipulation

Ceramic materials are hard, but can easily break upon impact. Manipulation should be kept to a minimum and follow these guidelines:

- Study the object before picking it up and note its weak points. Do not lift the object by those weak points (i.e. handles or lips).
- Use both hands to lift an object.
- Wear fitted nitrile or latex gloves, or use recently washed and dried hands.

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<sup>178</sup> Oakley and Jain, 2002, p.20.

<sup>179</sup> De Chavagnac, 2006, p.128.

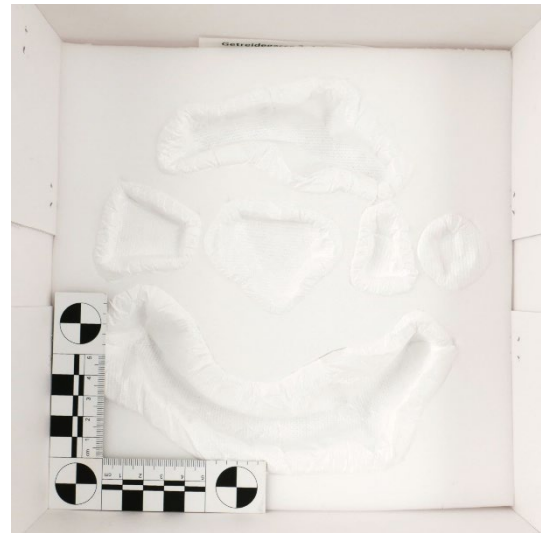
<sup>180</sup> Vinçotte, et al., 2009, p.6.

- When moving the objects short distances, make sure they are not subject to vibrations, by laying them on an absorbent material (i.e. polyethylene (PE) foam sheet).

## Storage

The objects should be shielded from dust. The shelving should not be overcrowded, to allow for visibility and limit risks when manipulation is necessary.

In order to ensure the best conservation conditions possible, limit risks of excessive manipulation and allow for transport, storage boxes were created. Following the model used in the archaeological collection, they are two-part boxes made of non-acidic cardboard and assembled with stainless steel staples. The objects are held in place thanks to PE foam, cut to shape and lined with Tyvek®\*. Small fragments are conserved in clear polypropylene boxes, with a PE foam lining (**Fig. 92, 93 to 98**).



*Figure 92: Inside of the box of object 7217*

## Cleaning and re-intervention

Light dusting may be carried out with a soft bristled brush if dust has accumulated on the surface.

If the gap-fills had to be removed, the object should be dismantled using a solvent for Paraloid® B-72, such as acetone or ethyl acetate. It may be applied liquid – although particular care should be taken not to smear the retouching media on the object – or by putting the object in a saturated solvent vapor environment.

In all cases, any intervention on the objects should be carried out by a conservator-restorer.



*Figure 93: Object 7216 in its storage box*



*Figure 94: Object 7217 in its storage box*



*Figure 95: Object 7218 in its storage box*



*Figure 96: Object 7219 in its storage box*



*Figure 97: Object 7220 in its storage box*



*Figure 98: The boxes of the treated objects*

## Results and discussion

At the end of the practical work, the objects are clean, which has increased homogeneity and vibrancy in the glaze colors. They are also physically stable, and can be handled and displayed, thanks to the glaze re-adhesion and the bonding. The objects are packaged in a way that protects them from abrasions, dust and excessive manipulation, and allows for transport. This also diminishes the risk of dissociation of fragments. Object 7216 is now visually unified and physically stable, which has augmented its aesthetic and didactic values greatly. Yet, the gap-fills are easily distinguishable upon closer inspection. The retouching appears slightly shiny, and therefore lighter in color under very bright direct light, due to the use of acrylics as retouching media. This should be taken into consideration for exhibition and photography. The colors generally appear more bright and less "dirty" on the gap-fills, and this is even more visible in photography than in real life.

Generally, the results of the conservation interventions are satisfying. The visual aspect and the ease of comprehension of the objects have been improved. The work respected delays, with the gap-filling and retouching on object 7216 being the most time-consuming interventions.

**Photos of all of the objects after intervention can be found in the appendix, p.94-97.**



*Figure 99: Object 7216-94 after intervention*

The goal of the conservation protocol was to avoid conservation-induced alteration as much as possible, by making the fills detachable, using materials with known ageing and reversibility, and by not pushing the cleaning too far, to a risk of damaging the original material. It should nevertheless be noted that the interventions did entail many repetitive manipulation of object 7216, which was a necessary risk to obtain these results. The use of silicone notably left some residues. It would be interesting for research to be further pursued, in order to find out the nature of these residues, their impact, and the products that produce the least amount of them. Also, mount-making could be considered for the objects which were not gap-filled, in order to display them in their functional position.

One "ready-made" solution does not exist for all objects of the same type, and further developments can always be made. For example, different Plastiline® hardness can be compared, varnishes for shiny fills could be studied, or less costly materials for mold-making, rather than silicones could be found. Our choices and actions can never be objective, and are always subject to a range of circumstances. A conservator's actions should be revisable by our colleagues and successors as much as possible, which is why extensive documentation and reversibility were extremely important during this work.

Finally, the ethics of gap-filling and retouching, especially on archaeological objects, are subjects on which the conservation profession will probably never come to a "one-size fits all" rule, but are important to study and update on nevertheless. The impact of conservation interventions on the comprehension of objects by the public was a fascinating, yet lacunary subject to look into. It would be interesting to pursue these studies, on a broader audience for example. Then, a collaboration with museologists and cultural mediators could be considered, to shine more light on the conservators' work and our impact on changing the materiality and cultural values of cultural heritage.

## Conclusion

At the end of this work, our objectives were fulfilled. Although the function of these objects remains a mystery, they definitely were luxury goods that belonged to the influential inhabitants of the Schatz-Haus after the second half of the 16<sup>th</sup> century – possibly the Rauchenberger or Mayr family. This was proven by documentation of the house's history and comparison with other objects and fashion history. The relief appliques on objects 7216 and 7217 being so similar to the relief on a pitcher produced in Wels, this might be a clue to the geographical origin of these objects.

Material analysis confirmed the nature of the lead-based fritted glaze with the use of some tin opacification and mineral pigments, notably cobalt from European mines. The presence of arsenic in most of the glazes and its function remain unexplained. We also determined that the differential degradation between the glaze colors did not originate in chemical composition, but most likely from other factors such as pigment size and imperfections occurred during firing.

The objects are now stable and clean, they can be easily apprehended and manipulated. The packing of the objects diminishes the risk of dissociation and loss of fragments, and the need for manipulation. Object 7216 has regained a cohesive and complete look, whilst the gap-fills are easily distinguishable upon closer inspection, thanks to the smooth and matte surface finish and *puntinato* retouching technique.

Concerning the detachable gap-filling, the material testing led to the creation of a technique for apertured objects. By using Plastiline® as a means of sculpting the gap-fills before making a plaster copy of them, the problem of not being able to directly create the fill out of plaster using a silicone or wax imprint was solved. The use of Modostuc® as a finishing layer and Golden® Fluid acrylics as a retouching media was proven effective. The methods employed allowed to minimize the usual risks of gap-filling, such as scratching and embedding plaster powder into the surface, and creating tensions with the expansion of plaster. The fragmentary look of the final object is also very interesting for an archaeological object. It would be useful to carry out further research on the best varnishes for gap-fills, to obtain the glossy look of glazing, if that was needed for other objects.

The final results of the practical work were considered very satisfying by the museum staff concerned. The object ARCH 7216-94 as well as a presentation of the conservation and research work carried out in this thesis will be published by the Salzburg Museum, in an issue of the "*Kunstwerk des Monats*" (Artwork of the month) in 2024.

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# Appendix

## 5. Acronyms and abbreviations

<b>Fig.</b>	Figure	<b>Raman</b>	Raman spectroscopy
<b>HE-arc CR</b>	Haute Ecole Arc, filière conservation-restauration	<b>RH</b>	Relative Humidity
<b>HKB</b>	Hochschule der Künste Bern	<b>SDS</b>	Safety Data Sheet
<b>ICOM</b>	International Committee of Museums	<b>SEM-EDS</b>	Scanning Electron Microscopy (SEM) and Energy-Dispersive X-ray Spectroscopy (EDS)
<b>MAK</b>	<i>Museum für Angewandte Kunst</i> Decorative Arts Museum, in Vienna	<b>SM</b>	Salzburg Museum
<b>PE</b>	Polyethylene	<b>XRF</b>	X-Ray Fluorescence Spectroscopy

## 6. Glossary

<b>Biscuit (ceramic)</b>	Unglazed ware that has had one firing. It generally precedes the glaze firing <sup>181</sup> .
<b>Cesspit</b>	An underground hole used to dispose of trash, solid and liquid waste.
<b>Chelating</b>	Characteristic of a medium containing chelating or complexing agents. These are compounds that can sequester ions (notably metals and calcium).
<b>Coiling (ceramic)</b>	A method of building a vessel using long coils of clay <sup>182</sup> .
<b>Cure inhibition</b>	In the event of contact with some materials, addition cure silicones can be subject to a non-cure. They can either remain runny completely, or have a sticky or gummy finish. The lower the level of platinum, the more easily the material can be poisoned or inhibited by certain chemicals or materials <sup>183</sup> .

<sup>181</sup> Oakley and Jain, 2002, p.103.

<sup>182</sup> Oakley and Jain, 2002, p.103.

<sup>183</sup> TechSil [online].

<b>Earthenware</b>	Low-fired ceramics with a porous body. Exposed or broken edges tend to be rough with pores, ranging in color from creamy-white to red-brown and black. When glazed, the otherwise porous ware is made waterproof. The glaze forms a distinct layer covering the underlying body and is often weakly attached <sup>184</sup> .
<b>Electrolyte</b>	Conductive substance, thanks to the presence of mobile ions.
<b>Glass transition temperature</b>	Temperature over which a polymer has sufficient mobility between its mobility to be able to flow <sup>185</sup> .
<b>Grog (ceramic)</b>	Powdered fired clay which is added to bodies to give texture, improve resistance to thermal shock and reduce shrinkage during firing <sup>186</sup> .
<b>Illusionism</b>	In conservation-restoration, a means to restore an object to look new or untouched by a restorer.
<b>Iridescence</b>	Variegated coloration of the surface of a glass or glaze. Because of weathering, layers of silica can form at the surface, which are interspersed with air spaces in between. Light passing through these air and glass layers, and the presence of metal oxides, create an optical interference phenomena <sup>187</sup> .
<b>Luting</b>	Using slip as an adhesive to glue ceramic elements together.
<b>Melamine</b>	Melamine is a sponge or foam-like material also sometimes called "magic eraser".  It is used with water, and when rubbed on a surface, disintegrates into small, abrasive particles <sup>188</sup> .

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<sup>184</sup> Oakley and Jain, 2002, p.104.

<sup>185</sup> Davison, 2003, p.208.

<sup>186</sup> Oakley and Jain, 2002, p.104.

<sup>187</sup> Davison, 2003, p.183.

<sup>188</sup> Preservation Equipment [online].

<b>Micromesh</b>	They are abrasives constructed with a thin layer of soft resilient material between a cloth back and abrasive crystals. This "cushioned" back allows an even cutting plane and allows for a very fine and smooth surface finish <sup>189</sup> .
<b>Pinhole</b>	A very small hole traversing through the glaze and reaching the ceramic body underneath.
<b>Plastic</b>	Malleable and deformable without breaking.
<b>Poly-addition cure</b>	Characteristic of a silicone with a platinum-based catalyzer. When curing, the molecules combine together without eliminating by-products <sup>190</sup> .
<b>Poly-condensation cure</b>	Characteristic of a silicone with a tin-based catalyzer. When curing, at least two reactants combine to form long macromolecular chains. By-products are released during this process (water, salts, alcohols) <sup>191</sup> .
<b>Porosity</b>	The property which allows a fired body to absorb liquids by capillary action. A low-fired earthenware is much more porous than porcelain due to the network of communicating small pores within the body <sup>192</sup> . Porosity decreases with vitrification.
<b>PVA Sponge</b>	Sponge made out of PVA polymer. It is hard when dry and becomes soft when made wet for a few hours. It has great water retention properties.
<b>Relative Humidity</b>	The relation, at a given temperature, between the quantity of water vapor contained in air, and the maximum quantity this same air could contain. In other words, RH is an indication of the saturation level of air, in percents (%) <sup>193</sup> .
<b>Slip trailing</b>	Using thick slip to draw decors on the object.
<b>Slip or slurry</b>	A liquid suspension of clay in water.

<sup>189</sup> Dieter Schmid Fine Tools [online].

<sup>190</sup> De Chavagnac, 2006, p.109.

<sup>191</sup> De Chavagnac, 2006, p.110.

<sup>192</sup> Oakley and Jain, 2002, p.105.

<sup>193</sup> Mardaga, 2001, p.12.

<p><b>Soluble salts</b></p>	<p>Ionic compounds that can be present in porous materials because of the penetration of components such as chlorides, nitrates and sulfates from the soil <sup>194</sup>. Some of them have a solid to liquid transition called deliquescence at a given relative humidity. This means below this RH, they will crystallize and take up more volume <sup>195</sup>. If the humidity varies frequently, the crystals will grow larger each time, and if these variations are particularly fast, the salt-containing water will not have had time to migrate to the surface before evaporation, meaning the crystallization will occur underneath the surface, causing spalling, flaking and powdering of the surface.</p>
<p><b>Throwing (ceramic)</b></p>	<p>The process of making pottery on a spinning wheel. A lump of plastic clay is centered on the wheel, then gradually, the potter makes an indentation in the lump, all the time keeping the clay lubricated with water. The form is gradually opened up and the sides of the vessel lifted up from the clay <sup>196</sup>.</p>
<p><b>Transition metal</b></p>	<p>Metallic elements occupying the central block of the periodic table. In ceramics and glazes, some are used as colorants.</p>
<p><b>Trimming marks</b></p>	<p>Marks left by the process of turning. When the clay is leather-hard, the vessel is attached upside down to the potter's wheel, and the excesses shaved away with a sharp tool <sup>197</sup>.</p>
<p><b>Tyvek®</b></p>	<p>Synthetic material made from high-density spun-bound polyethylene fibers. It is a non-woven high-density polyethylene (HDPE) <sup>198</sup> sheet with perforations used as an isolation, non-abrasive layer for packing objects.</p>

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<sup>194</sup> Conserve O Gram 6/5, 1998, p.2.

<sup>195</sup> Peng, et al., 2022, p.580.

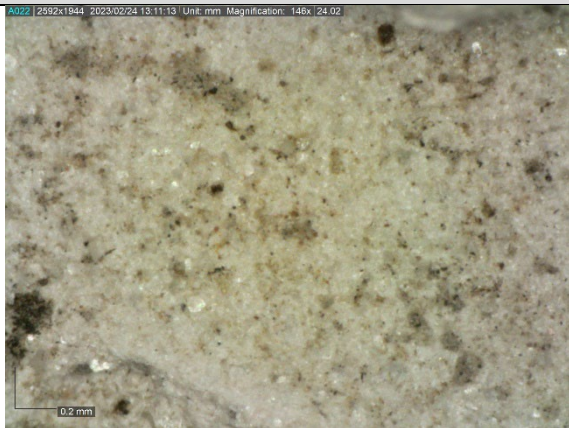
<sup>196</sup> Oakley and Jain, 2002, p.106.

<sup>197</sup> Oakley and Jain, 2002, p.107.

<sup>198</sup> Dupont [online].

## 7. Detailed descriptions of the objects

### Object nr. 7216-94– Apertured vessel with repetitive anthropomorphic decors

<b>Inv. Nr.: ARCH 7216-94</b>	
<p><b>Shape:</b> Hollow ware, dish or platter with a flat base, cylindrical shape, 4 lips, 2 handles, relief appliques and decorative apertures.</p> <p><b>Decors:</b> Vertical and diagonal bands. Repetitive anthropomorphic figures representing a woman in 16<sup>th</sup> century costume.</p>	
<p><b>Dimensions (dxh):</b> 18 x 8,5 cm</p>	
<p><b>Methods of manufacture:</b></p> <ul style="list-style-type: none"> <li>• Turning</li> <li>• Hand pulling and luting* of the handles</li> <li>• Molding of the appliques and luting</li> <li>• Cutting of the lips and the apertures</li> <li>• Polychrome glazing</li> </ul>	
<p><b>Glazing:</b></p> <ul style="list-style-type: none"> <li>• Lead-based glaze</li> <li>• Outside: yellow, light blue, dark blue and green</li> <li>• Inside: clear-yellowish</li> </ul>	
<b>Description of the paste</b>	
<p><b>Hardness</b><sup>199</sup>: 6-7 (Mohs)</p>	
<p><b>Color:</b> light beige to light grey</p>	
<p><b>Inclusions:</b> Small and of moderate frequency. They have angular shapes and seem to be of mineral origin, like sand or mica. There are a few voids in the paste.</p>	

**Table 8:** Descriptive table of object ARCH 7216-94


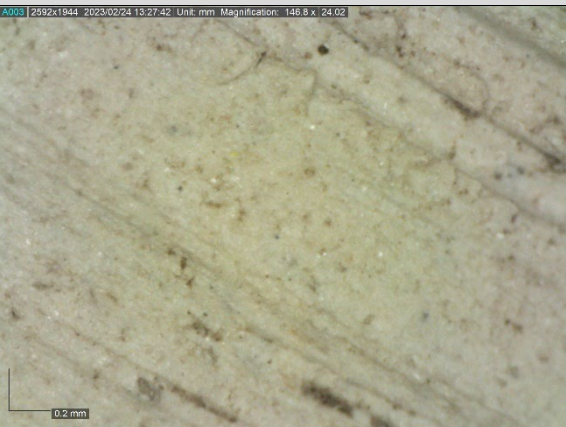
<sup>199</sup> Hardness is evaluated by scratching the surface with a fingernail or a steel needle. If the material is scratched by the nail, its hardness can be estimated between 3 and 4 on the Mohs scale. If it is scratched by the needle, it is between 6 and 7. According to Buys and Oakley, 1996, p.42.

**Object nr. 7217-94 – Apertured vessel with anthropomorphic, geometric and botanical decors**

<b>Inv. Nr.: ARCH 7217-94</b>	
<p><b>Shape:</b> Hollow ware, dish or platter with a flat base, cylindrical shape, 4 lips, 2 handles, relief appliques and decorative apertures.</p> <p><b>Decors:</b> Vertical and diagonal bands. Repetitive anthropomorphic figures representing a woman in 16<sup>th</sup> century costume, oval shape surrounded by leaves and one botanical decor.</p>	
<p><b>Dimensions (dxh) :</b> 18 x 7,5 cm</p>	
<p><b>Methods of manufacture:</b></p> <ul style="list-style-type: none"> <li>• Turning</li> <li>• Hand pulling and luting of the handles</li> <li>• Molding of the appliques and luting</li> <li>• Cutting of the apertures</li> <li>• Polychrome glazing</li> </ul>	
<p><b>Glazing:</b></p> <ul style="list-style-type: none"> <li>• Lead-based glaze</li> <li>• Outside: yellow, light blue, dark blue and green</li> <li>• Inside: clear-yellowish</li> </ul>	
<b>Description of the paste</b>	
<p><b>Hardness:</b> 6-7 (Mohs)</p>	
<p><b>Color:</b> light beige to light grey</p>	
<p><b>Inclusions:</b> Small and of moderate frequency. They have angular shapes and seem to be of mineral origin, like sand or mica. There are a few voids in the paste.</p>	



*Table 9: Descriptive table of object ARCH 7217-94*

**Object nr. 7218-94 – Base of a vessel**

<b>Inv. Nr.: ARCH 7218-94</b>	
<p><b>Shape:</b> Circular base of a vessel. A thin, flat base is surmounted by two levels of rounded rings. Rectangular elements, bent in an S shape are attached to this base, but are mostly missing. The complete archaeological profile is unknown.</p>	
<p><b>Dimensions (dxh) :</b> 11 x 6 cm</p>	
<p><b>Methods of manufacture:</b></p> <ul style="list-style-type: none"> <li>• Turning of the circle (throwing rings or trimming marks are visible)</li> <li>• Hand forming or molding of the added elements, then luting.</li> </ul>	
<p><b>Glazing:</b></p> <ul style="list-style-type: none"> <li>• Lead-based glaze</li> <li>• Outside: yellow, light blue, dark blue and green</li> <li>• Underside: unglazed</li> </ul>	
<b>Description of the paste</b>	
<p><b>Hardness:</b> 6-7 (Mohs)</p>	
<p><b>Color:</b> light beige</p>	
<p><b>Inclusions:</b> Scarce and irregularly sorted inclusions. White to gray and seemingly of mineral origin, such as sand or mica.</p>	








*Table 10: Descriptive table of object ARCH 7218-94*

**Object nr. 7219-94 – Lid or base of a vessel**

<b>Inv. Nr.: ARCH-7219-94</b>	
<p><b>Shape:</b> Base or lid of a vessel. Flat circular shape, with a smaller unglazed circular lip in the center. Some attached elements are missing from the top and bottom of the element. The archaeological profile is incomplete.</p> <p><b>Decors:</b> Incised lines, waves and dots.</p>	
<p><b>Dimensions (dxh) :</b> 14 x 3 cm</p>	
<p><b>Methods of manufacture:</b></p> <ul style="list-style-type: none"> <li>• Turning of the circle (throwing rings or trimming marks are visible)</li> <li>• Hand forming or molding of the added elements, then luting.</li> <li>• Incising and slip trailing* for the decors</li> </ul>	
<p><b>Glazing:</b></p> <ul style="list-style-type: none"> <li>• Lead-based glaze</li> <li>• Outside: yellow, light blue, dark blue, white and green</li> <li>• Inside: clear-yellowish</li> </ul>	
<b>Description of the paste</b>	
<p><b>Hardness:</b> 6-7 (Mohs)</p>	
<p><b>Color:</b> light beige</p>	
<p><b>Inclusions:</b> Very scarce and irregularly sorted inclusions. White to gray and seemingly of mineral origin, such as sand or mica.</p>	

*Table 11: Descriptive table of object ARCH 7219-94*

**Object nr. 7220-94 – Top of a vessel**

<b>Inv. Nr.: ARCH 7220-94</b>	
<p><b>Shape:</b> The fragments mostly constitute the top edge of a glazed vessel. A yellow ring is surmounted by alternating scallop edged blue and white rectangles – the blue ones parallel to the ground, the white ones perpendicular. Under the rim are attached various decorated elements, such as flowers, bands and hemi-circles with incised motifs, but they are broken and in great part missing.</p> <p>Four fragments of the body remain, 3 undetermined and one piece of a handle, formed by three twisting coils.</p> <p>The complete archaeological profile is unknown.</p>	
<p><b>Dimensions (dxh) :</b> 15 x 3,5 cm</p>	
<p><b>Methods of manufacture:</b></p> <ul style="list-style-type: none"> <li>• Hand forming or molding of the added elements, then luting.</li> <li>• Incision of the decors</li> <li>• Polychrome glazing</li> </ul>	
<p><b>Glazing:</b></p> <ul style="list-style-type: none"> <li>• Lead-based glaze</li> <li>• Outside: Yellow, white, dark blue and green</li> <li>• Inside : clear-yellowish glaze</li> </ul>	
<b>Description of the paste</b>	
<p><b>Hardness:</b> 6-7 (Mohs)</p>	
<p><b>Color:</b> light beige</p>	
<p><b>Inclusions:</b> Scarce and irregularly sorted inclusions. White to gray and seemingly of mineral origin, such as sand or mica.</p>	

*Table 12: Descriptive table of object ARCH 7220-94*

## 8. Photographs



**Figure 100:** Object 7216-94, after intervention, from above



**Figure 101:** Object 7216-94, after intervention, from the side, view 1



**Figure 102:** Object 7216-94, after intervention, from the side, view 2



**Figure 103:** Object 7216-94, after intervention, from the side, view 3



**Figure 104:** Object 7216-94, after intervention, from the side, view 4



**Figure 105:** Object 7216-94, after intervention, from the side, view 5



**Figure 106:** Object 7217-94, after intervention, fragment 1, side view



**Figure 107:** Object 7217-94, after intervention, fragment 1, side view



**Figure 108:** Object 7217-94, after intervention, fragment 1, inside



**Figure 109:** Object 7217-94, after intervention, fragment 2, side view



**Figure 110:** Object 7217-94, after intervention, fragment 2, inside



**Figure 111:** Object 7218-94, after intervention, top view



**Figure 112:** Object 7218-94, after intervention, bottom view



**Figure 113:** Object 7218-94, after intervention



**Figure 114:** Object 7219-94, after intervention, side view



**Figure 115:** Object 7219-94, after intervention, top view (?)



**Figure 116:** Object 7219-94, after intervention, bottom view (?)



**Figure 117:** Object 7220-94, after intervention, bottom view



**Figure 118:** Object 7220-94, after intervention, top view



**Figure 119:** Object 7220-94, after intervention, fragment 1



**Figure 120:** Object 7220-94, after intervention, fragment 2

## 9. Analytical data

### 9.1 XRF

#### Description of the technique

X-ray fluorescence spectroscopy (XRF) is a non-destructive analytical technique used to determine the elemental composition of materials<sup>200</sup>. Portable instruments provide semi-quantitative results, with a detection limit at elements under the molecular weight of sulfur ( $Z=16$ )<sup>201</sup>. It was used to evaluate the chemical composition of the ceramic body and of the glazes.

#### Analysis parameters

**Operator:** Dr. Christian Degrigny

**Instrument:** ThermoFisher®, Niton XL3t

**Mode:** Soils and Minerals

**Measurement duration:** 180 seconds

**Analysis window diameter:** 7 mm

**Distance to the object:** 0.1 – 1 cm

50 kV X-ray tube

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<sup>200</sup> A more precise description of the technique can be found in Stuart, 2007, p.234-237.

<sup>201</sup> *ThermoFisher Scientific* [online].

### Analytical data

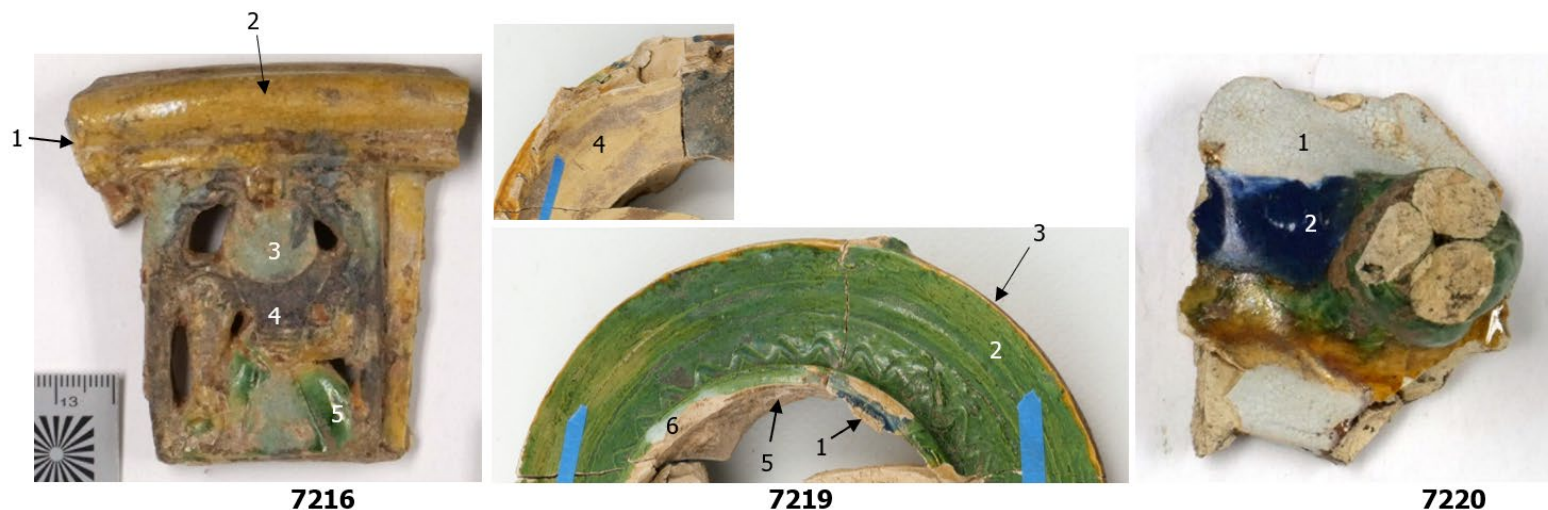


Figure 121: Localization of the XRF analysis points

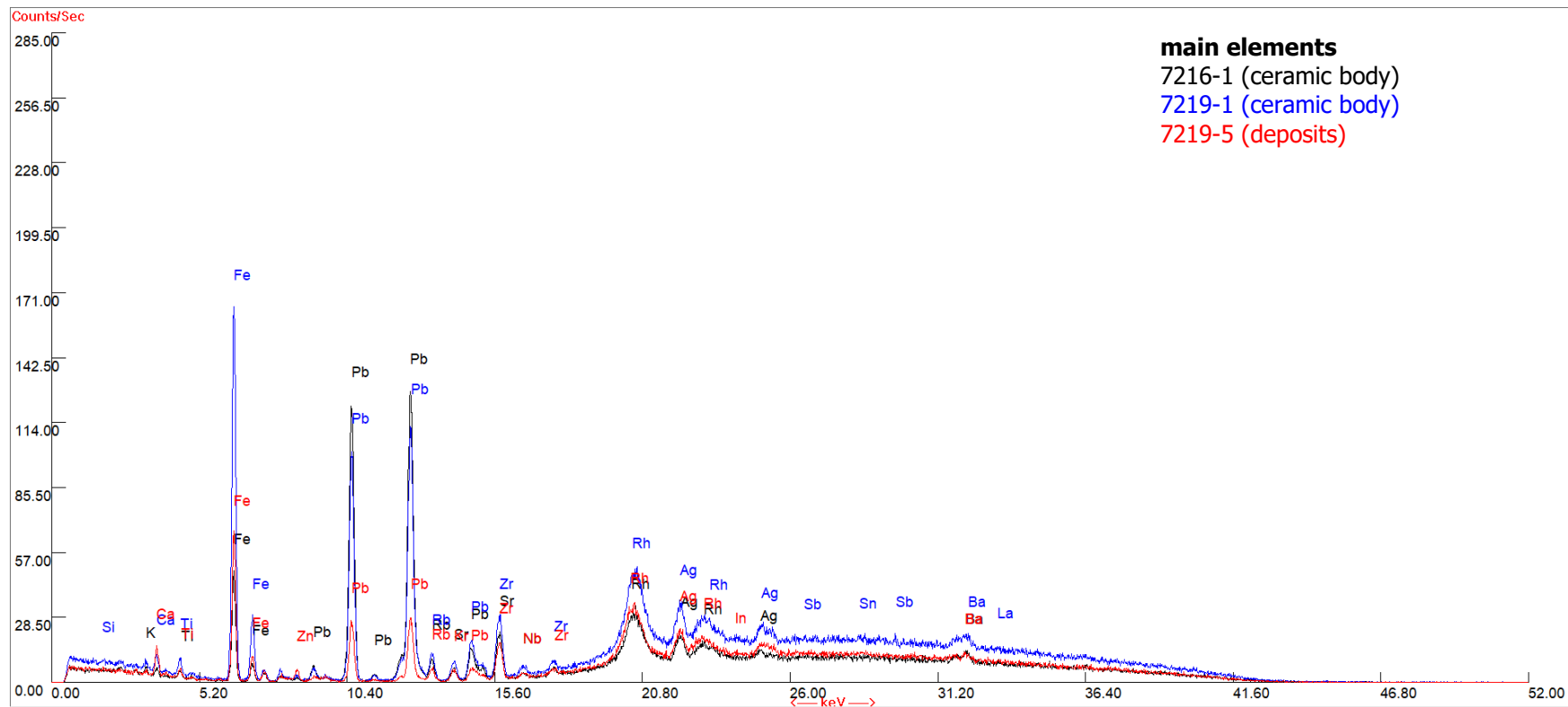
		Al	Si	Pb	Ti	Ba	Cu	As	Co	Fe	Sb	Sn	Ca	K	Zn	P	Cl	S	Bal
7216	1 (body)	9	27	0.7	0.3	-	-	-	-	1	-	-	1	1.5	-	1	0.3	0.5	58
	2 (yellow)	0.7	13	22	-	0.3	-	1.5	-	0.7	-	-	0.2	0.2	-	-	-	-	62
	3 (l. blue)	-	9	23	-	-	0.2	1.2	-	0.4	-	1	0.8	0.4	-	0.6	0.4	-	62
	4 (d. blue)	-	10	17	-	0.1	-	1.2	0.1	0.4	-	0.2	1	1.2	-	0.5	0.5	-	67
	5 (green)	1.5	14	24	-	0.2	1.2	1.4	-	0.2	-	0.4	0.4	0.4	0.3	0.2	0.2	-	56
	6 (l. blue)	-	14.5	27	-	0.2	0.6	1.1	-	0.2	-	2.3	0.8	0.5	0.2	0.2	0.4	-	52
7219	1 (body)	9	24	0.4	0.5	-	-	-	-	2.3	-	-	1.4	1.1	-	2	0.1	0.8	59
	2 (green)	-	1.7	14	-	-	1.2	1	-	0.3	-	-	0.2	0.2	-	-	0.2	-	81
	3 (yellow)	-	6	42.3	-	0.1	-	2	-	2	-	-	0.8	0.5	-	1.3	0.7	0.7	43
	4 (l. yellow)	-	11	28.5	-	0.2	-	1.7	-	0.1	-	-	0.9	0.2	-	0.6	0.4	-	56
	5 (deposit)	3.5	11	0.1	0.4	-	-	-	-	1.4	-	-	3.8	0.8	-	0.4	0.2	0.2	78
	6 (l. blue)	1.2	15	16	-	0.1	0.7	0.8	-	0.3	-	5.3	0.5	0.4	-	0.2	0.3	0.4	58
7220	1 (white)	-	-	18	-	0.1	0.3	0.8	-	0.3	-	10	0.2	0.3	-	0.2	0.2	-	59
	2 (d. blue)	-	8	12	-	0.1	0.5	0.8	0.2	0.6	-	0.8	0.4	0.7	-	-	0.2	-	75

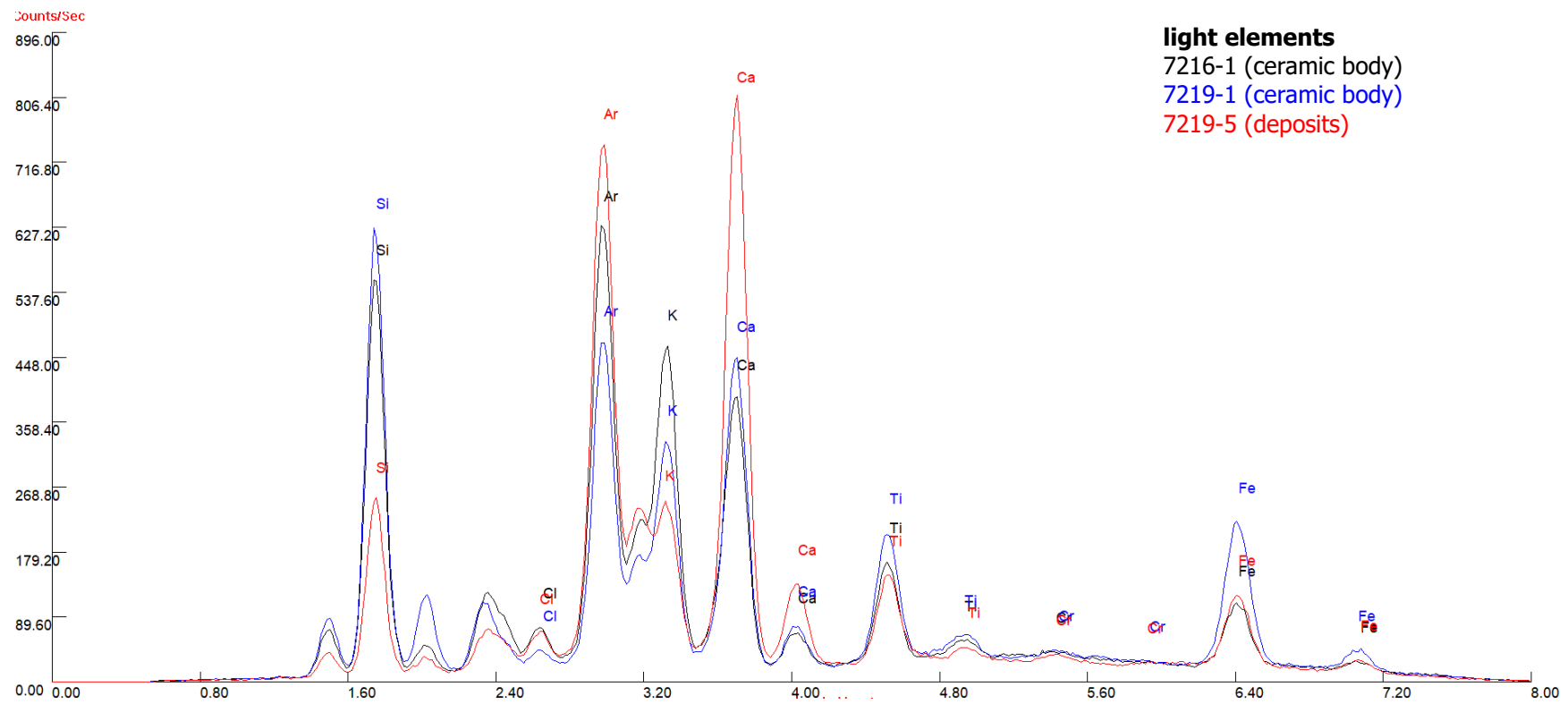
Table 13: Results of the XRF analysis. Highlighted are the most important elements.

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BAL : O, C, N, etc.

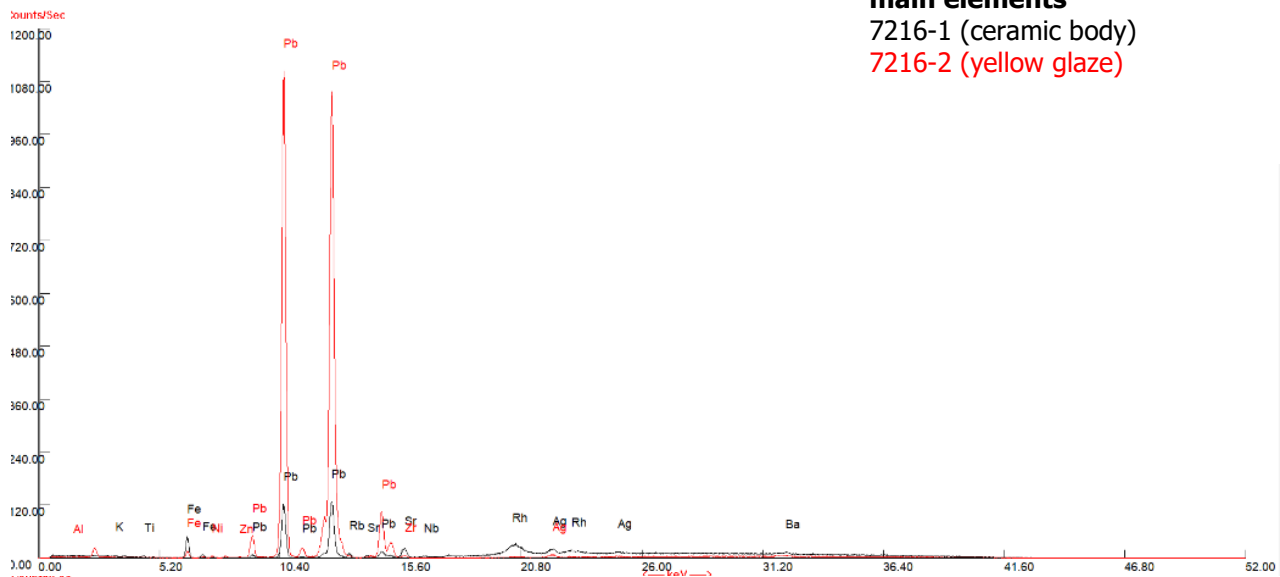
### Ceramic bodies / deposits





**light elements**  
7216-1 (ceramic body)  
7219-1 (ceramic body)  
7219-5 (deposits)

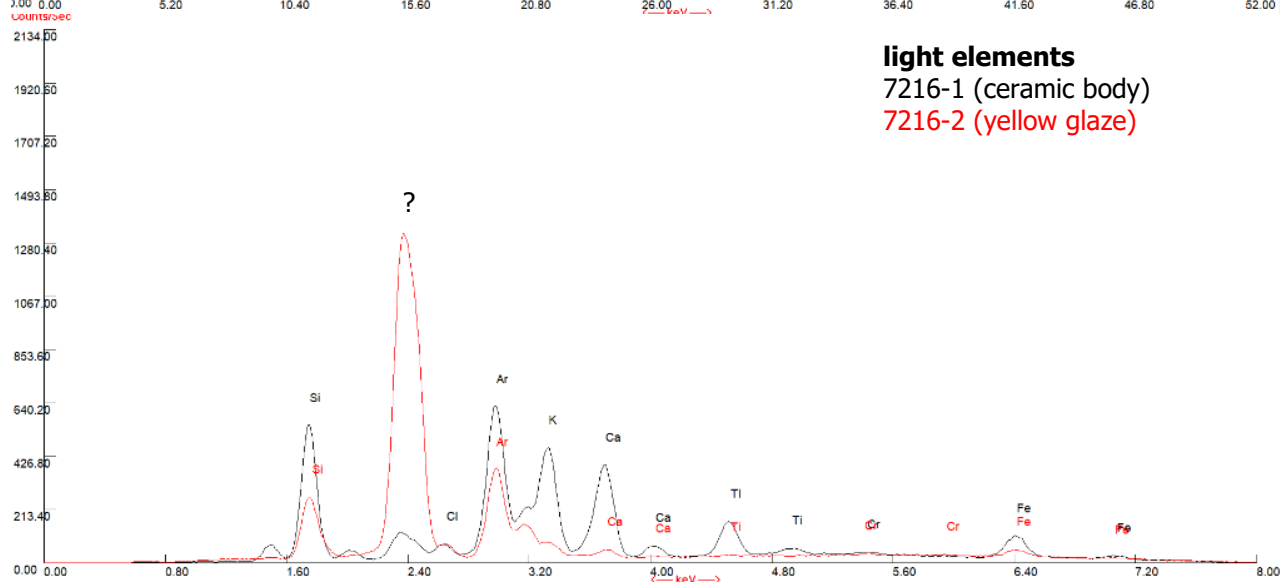
### Ceramic body and yellow glazes



#### main elements

7216-1 (ceramic body)

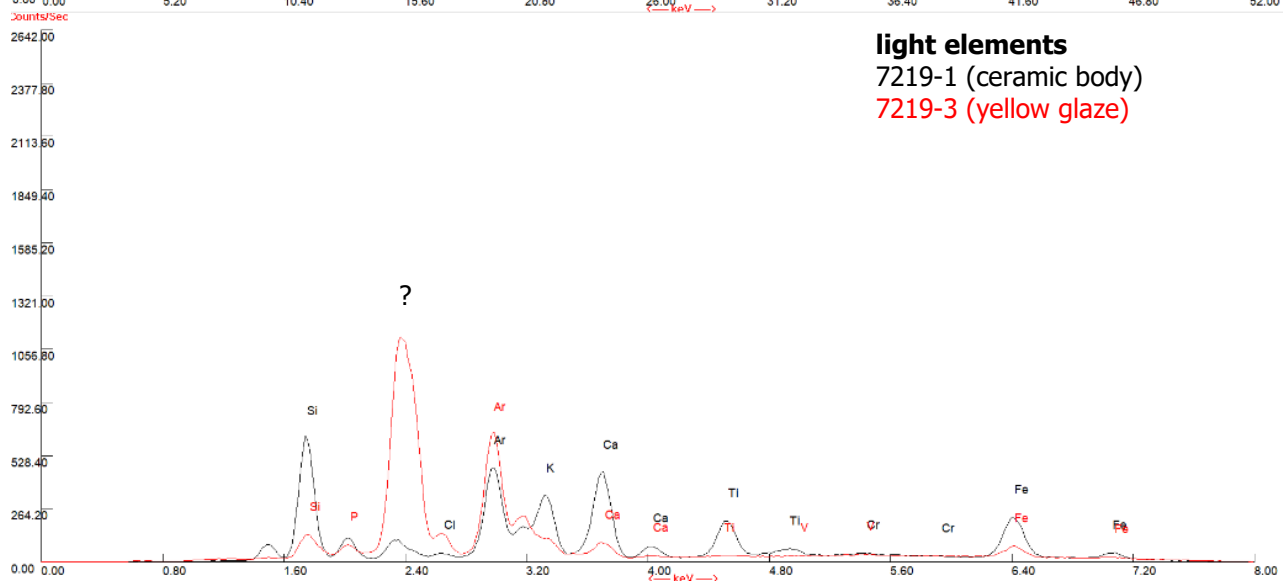
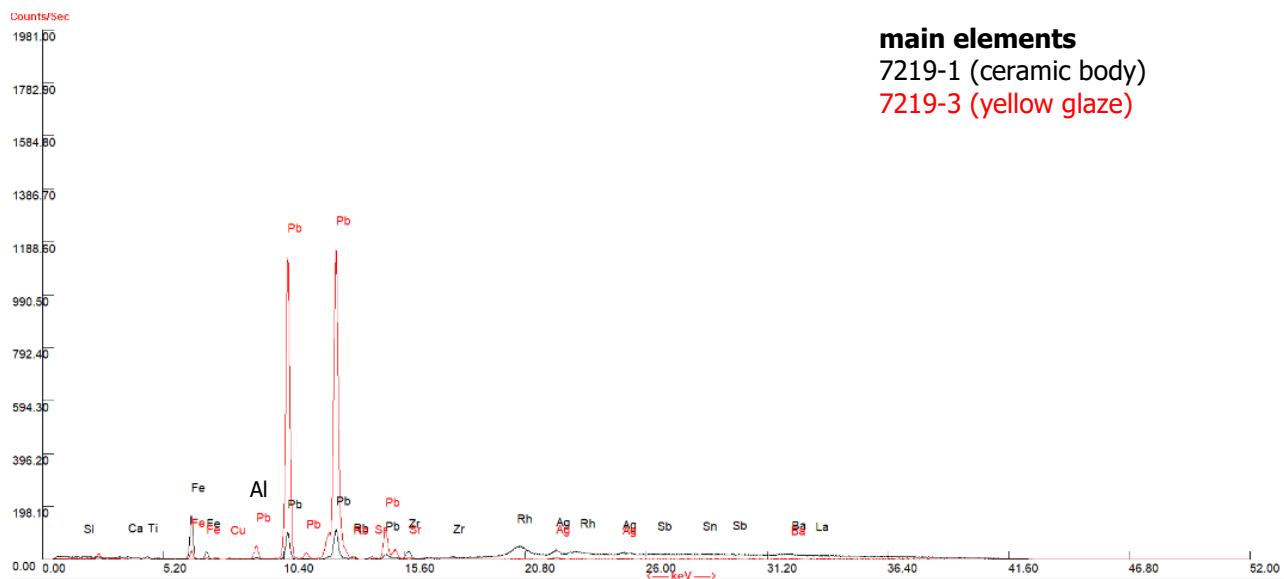
7216-2 (yellow glaze)



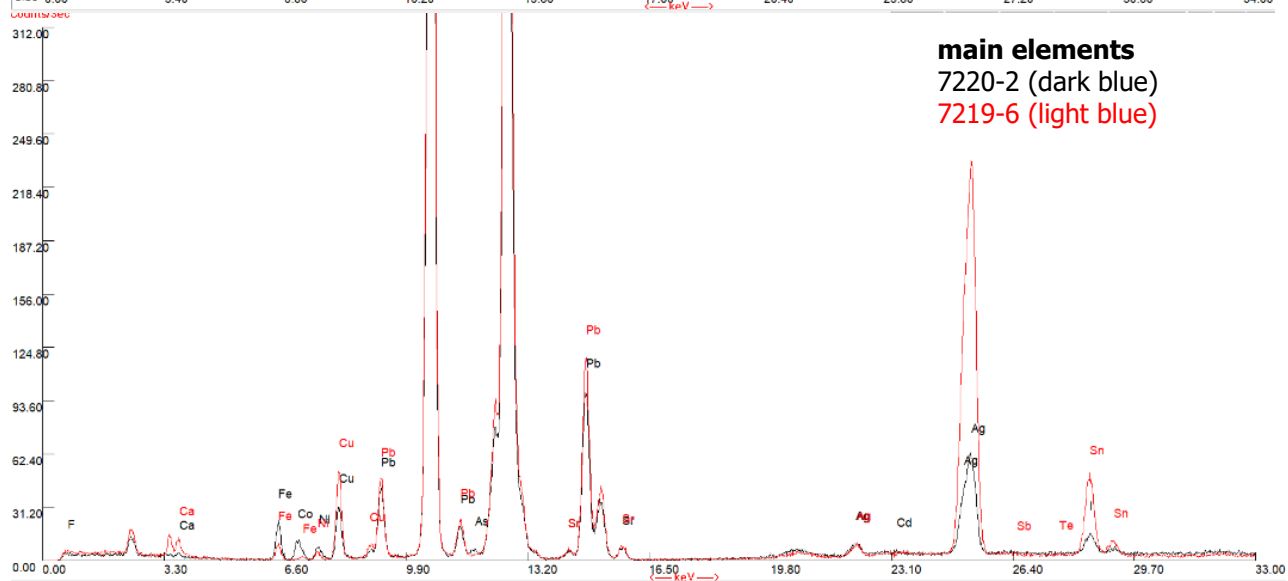
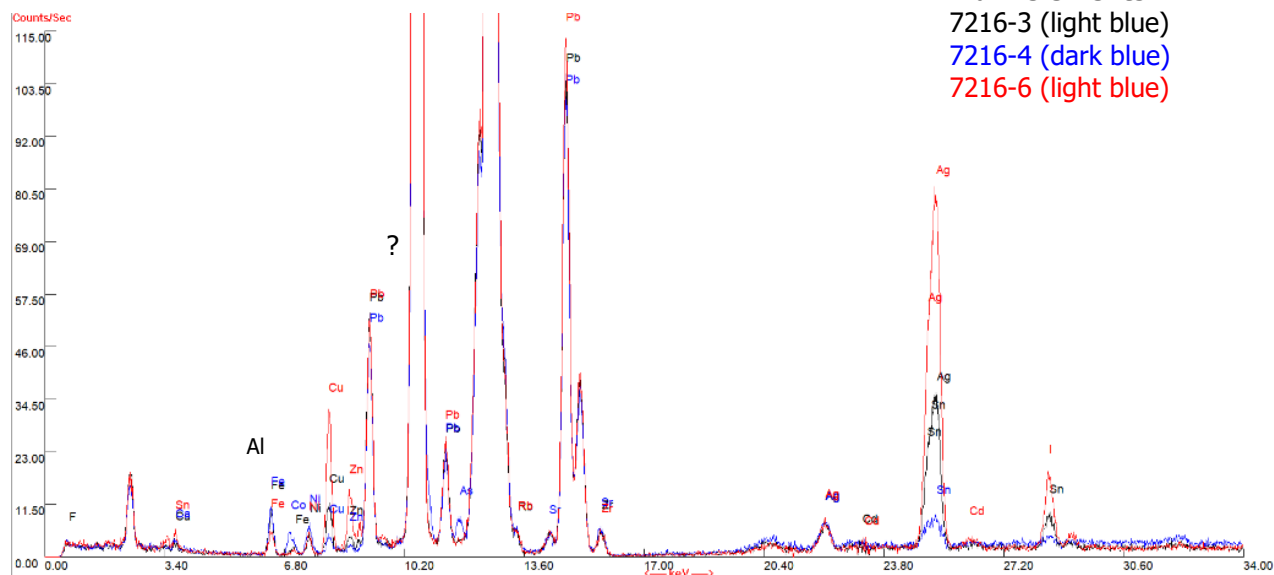
#### light elements

7216-1 (ceramic body)

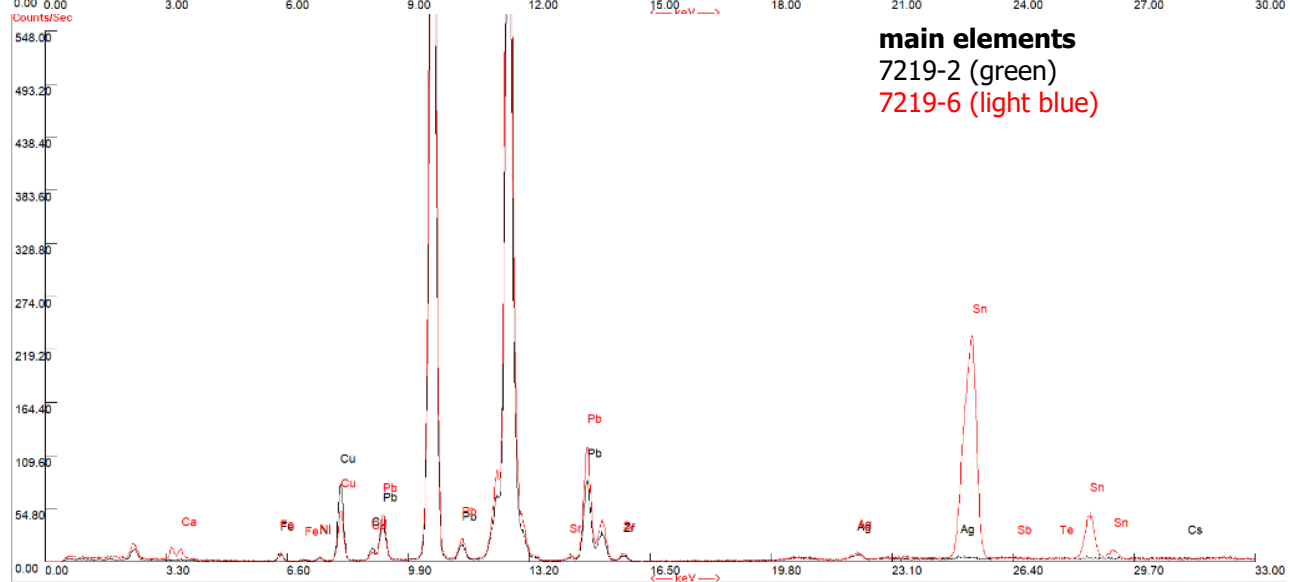
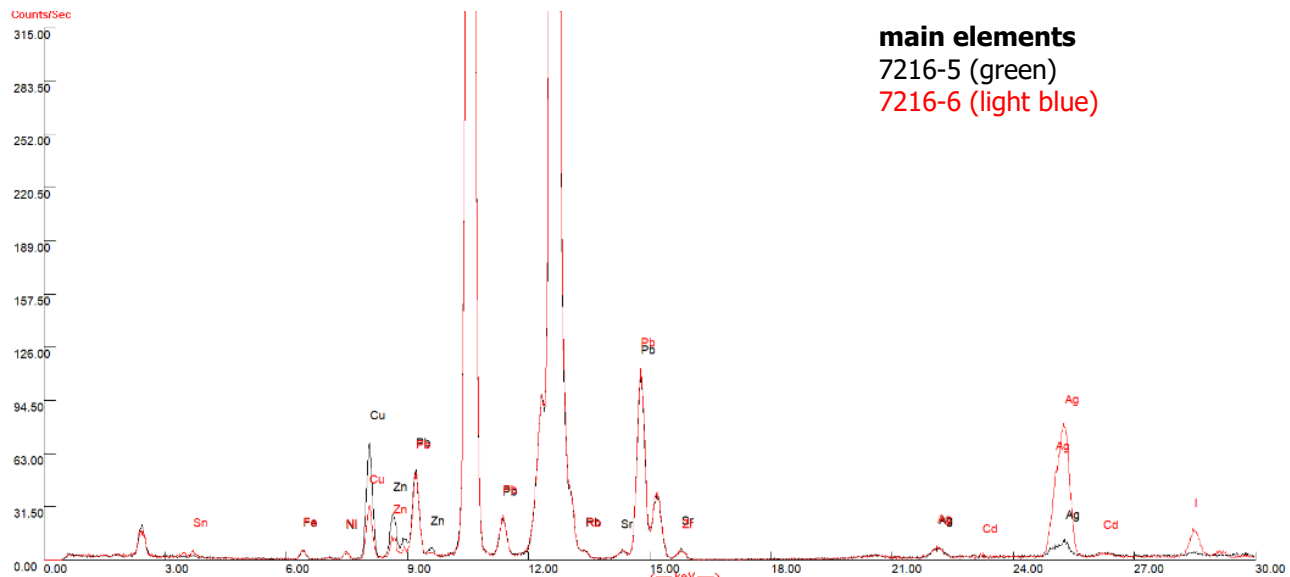
7216-2 (yellow glaze)



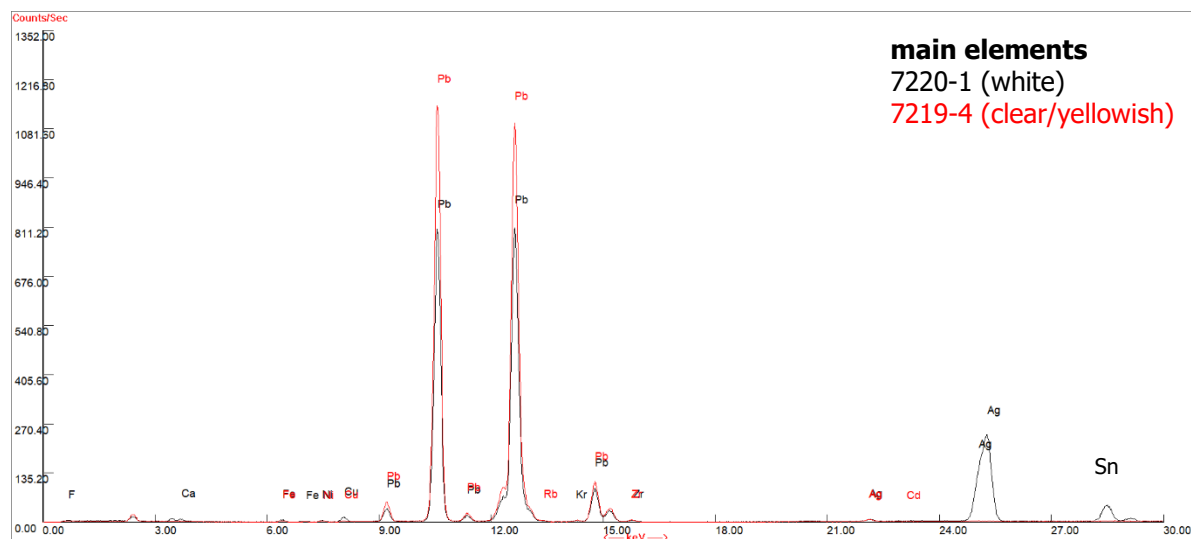
### Light blue / dark blue glazes



### Green / light blue glazes



## White / clear yellowish glazes



### Interpretation of the results

The **ceramic bodies** between objects 7216 and 7219 have a very similar composition. They are composed of clay containing silica (Si), iron (Fe) and alumina (Al), with traces of phosphorus (P), lead (Pb) and titanium (Ti).

The **deposits** analyzed have the same composition, with a higher calcium (Ca) concentration.

The glazes' basic composition is silica (Si) and lead (Pb). All of the glazes on one same object seem to have basically identical composition, with variations coming from the colorants. The **white** is obtained thanks to tin (Sn), **yellow** probably because of iron and lead, **green** because of copper (Cu), and **dark blue** thanks to cobalt (Co). Surprisingly, the **light blue** does not contain cobalt, but copper and tin.

All of the glazes were found to contain arsenic (As) in slightly varying amounts, up to 2% wt. This could indicate its presence is not related to coloration but to its intentional or unintentional presence in the basic glaze composition.

## 9.2 *Raman spectroscopy*

### **Description of the technique**

Raman spectroscopy is a non-destructive analytical technique, studying the way in which radiation is scattered by a sample, by using lasers as an excitation source. This technique is coupled with a microscope, which allows for focusing on details as small as  $1\ \mu\text{m}$ <sup>202</sup>. It provides results dependent on the chemical structure and crystallinity of the components present. It was used to try to determine the nature of the pigments or colorants in the glazes.

Because of timing reasons, only object 7216 was analyzed.

### **Analysis parameters**

**Operator:** Dr. Nadim Scherrer

**Instrument:** Renishaw InVia (2007) System

**Focal length:** 250 mm

**Spectral resolution:** 1 - 0,5  $\text{cm}^{-1}$

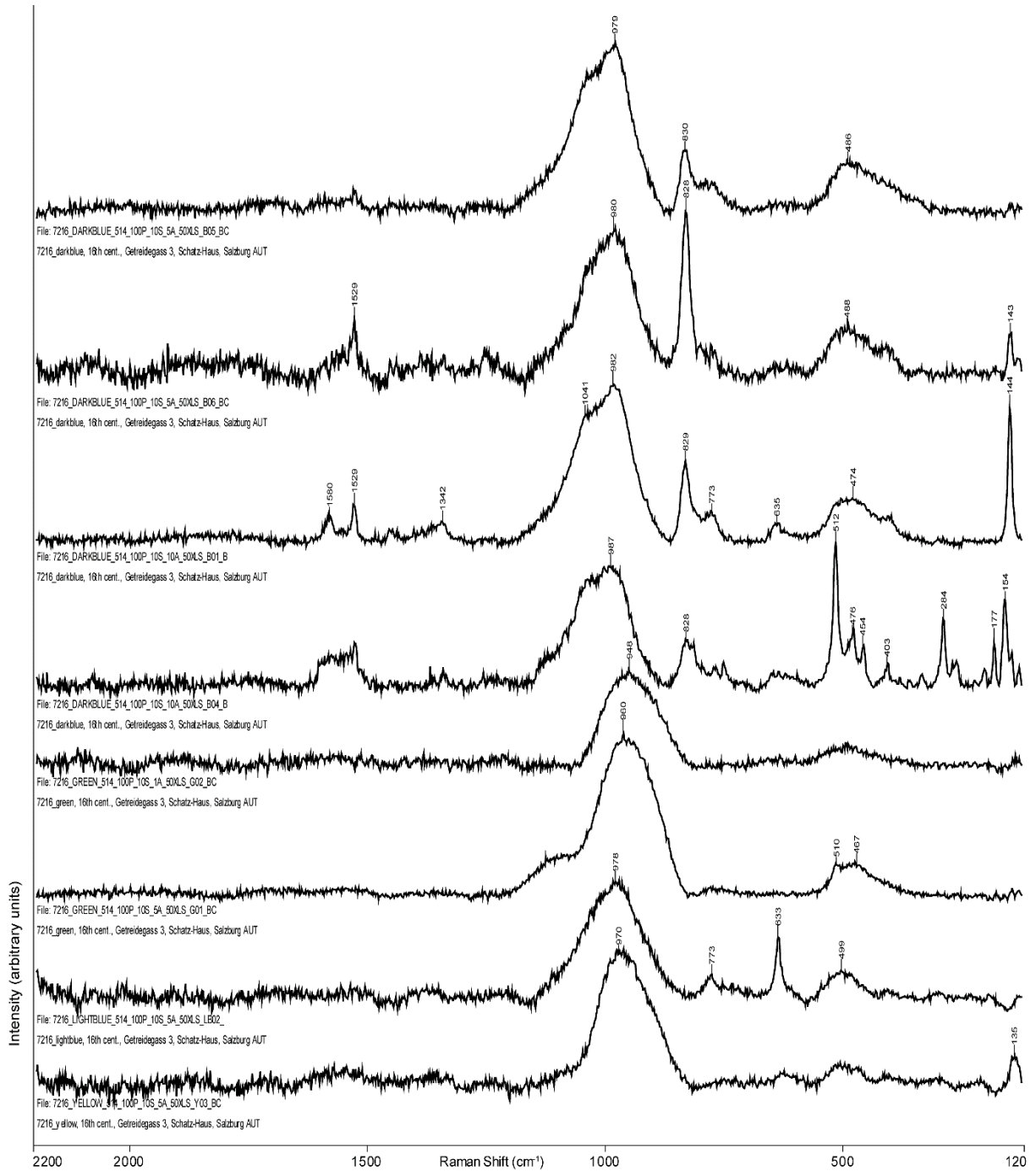
**Laser:** 514 nm (Ar-type)

**N-Plan Objectives on Leica DM LM Microscope :** 5x, 20x, 50x, 100x

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<sup>202</sup> A more precise description of the technique can be found in Stuart, 2007, p.136-139.

### Analytical data



**Figure 122:** Raman spectra of all the glaze colors analyzed on object 7216 – dark blue, green, light blue and yellow  
© N. Scherrer, HKB

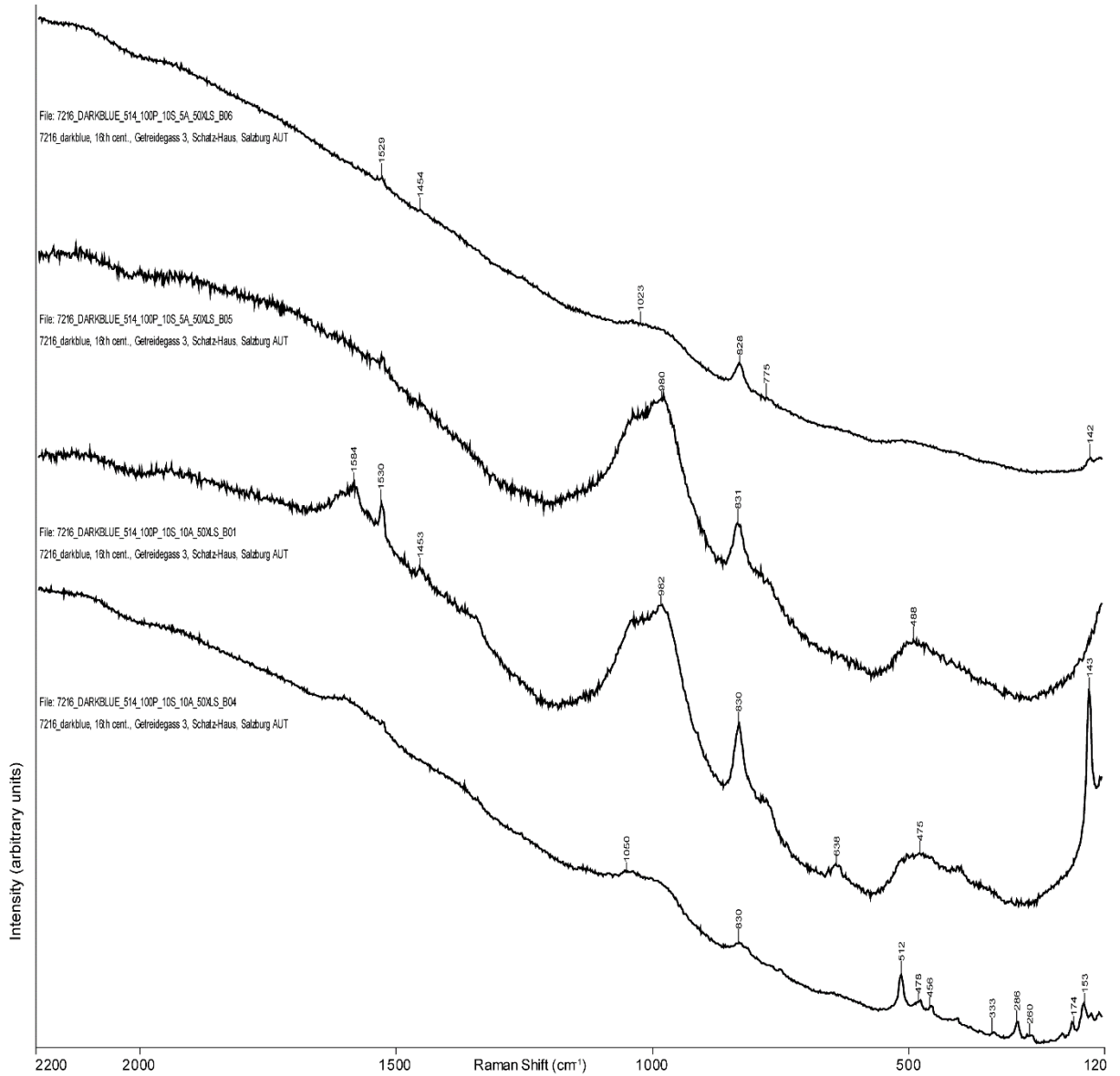


Figure 123 : Raman spectra of the dark blue glaze (7216)

© N. Scherrer, HKB

## Interpretation of the results

In all glazes, the broad band with its maximum around  $980\text{ cm}^{-1}$  is characteristic of a silicate (**Si-O-Si**)<sup>203</sup>. Also, the peaks around  $500\text{ cm}^{-1}$  are seemingly linked to the presence of a feldspar, namely **microcline** ( $\text{KAlSi}_3\text{O}_8$ , which could contain impurities such as Fe, Ca, Na,  $\text{H}_2\text{O}$ , etc.)<sup>204</sup>.

In the **dark blue glaze**, the peak around  $828 - 830\text{ cm}^{-1}$  can be associated to **olivine**, a recombination of cobalt with silica ( $\text{Co}_2\text{SiO}_4$ )<sup>205</sup>. The peak around  $143\text{ cm}^{-1}$  was compared to **anatase**, a form of titanium dioxide ( $\text{TiO}_2$ )<sup>206</sup>. However, this does not correlate with the SEM-EDS and XRF data, so it might be incorrect interpretation. The peaks around  $1041\text{ cm}^{-1}$  and  $1529\text{ cm}^{-1}$  could not be interpreted.

In the **green glaze**, no particular Raman signature linked to a pigment has been found. Literature tells us  $\text{Cu}^{2+}$  does indeed not have a specific Raman signature<sup>207</sup>.

In the **light blue glaze**, the peaks at  $633\text{ cm}^{-1}$  and  $773\text{ cm}^{-1}$  correlate to **cassiterite**, which is a tin oxide ( $\text{SnO}_2$ ).

In the **yellow glaze**, the peaks at  $136\text{ cm}^{-1}$  and  $501\text{ cm}^{-1}$  are similar to the Raman signature of **lead-tin yellow** (Pb, Sn and Sb)<sup>208</sup>. However, no traces of tin or antimony have been found in the yellow glazes during the SEM-EDS and XRF investigations, probably indicating this is a wrong interpretation.

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<sup>203</sup> Alonso-Olazabal, et al., 2022, p.1210.

<sup>204</sup> Freeman, et al., 2008, p.1804.

<sup>205</sup> Colomban, 2019, p.5.

<sup>206</sup> Klouzkova, 2019, p.453 and Mamedov, 2020, p.42.

<sup>207</sup> Colomban, 2019, p.5.

<sup>208</sup> Ferrer, et al., 2012 and Colomban, 2019, p.5.

### 9.3 SEM-EDS

#### Description of the technique

SEM-EDS is a combination of an imaging and an analysis technique. SEM creates the image of an object using a beam of electrons passing over the surface. This results in very high magnification and high resolution three-dimensional images of a surface. Energy dispersive spectroscopy (EDS) allows the elemental characterization of the surface<sup>209</sup>. In this case, since it was not possible to coat the object to make it conductive, this process had to be done in a low-vacuum setting which results in a lower resolution. This technique was used to more precisely characterize the elements present in the glazes and corroborate the results obtained with the XRF. Because of timing reasons, only object 7216 was analyzed.

#### Analysis parameters

**SEM instrument:** Zeiss EVO MA 10 (2014)

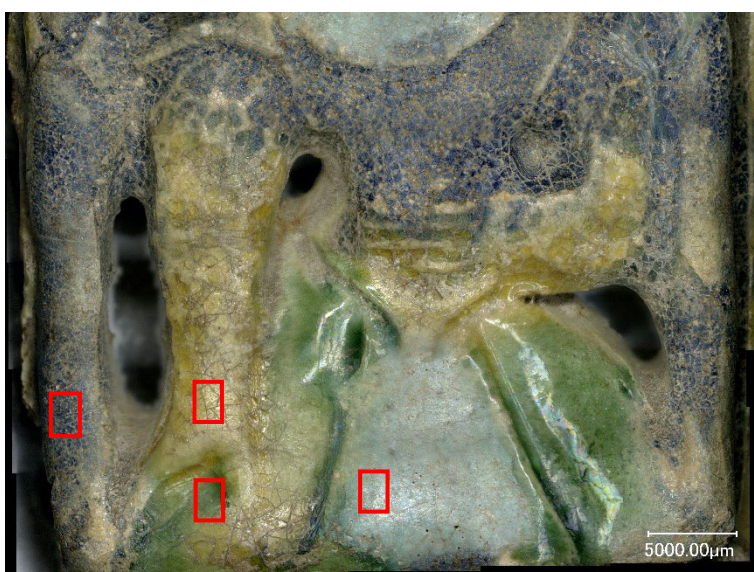
**EDS instrument:** Thermo NORAN System 7 (2014)

**Pressure:** 40 Pa

**Magnification:** 50 – 1000x

**Voltage:** 20 kV

**Power:** 500 pA

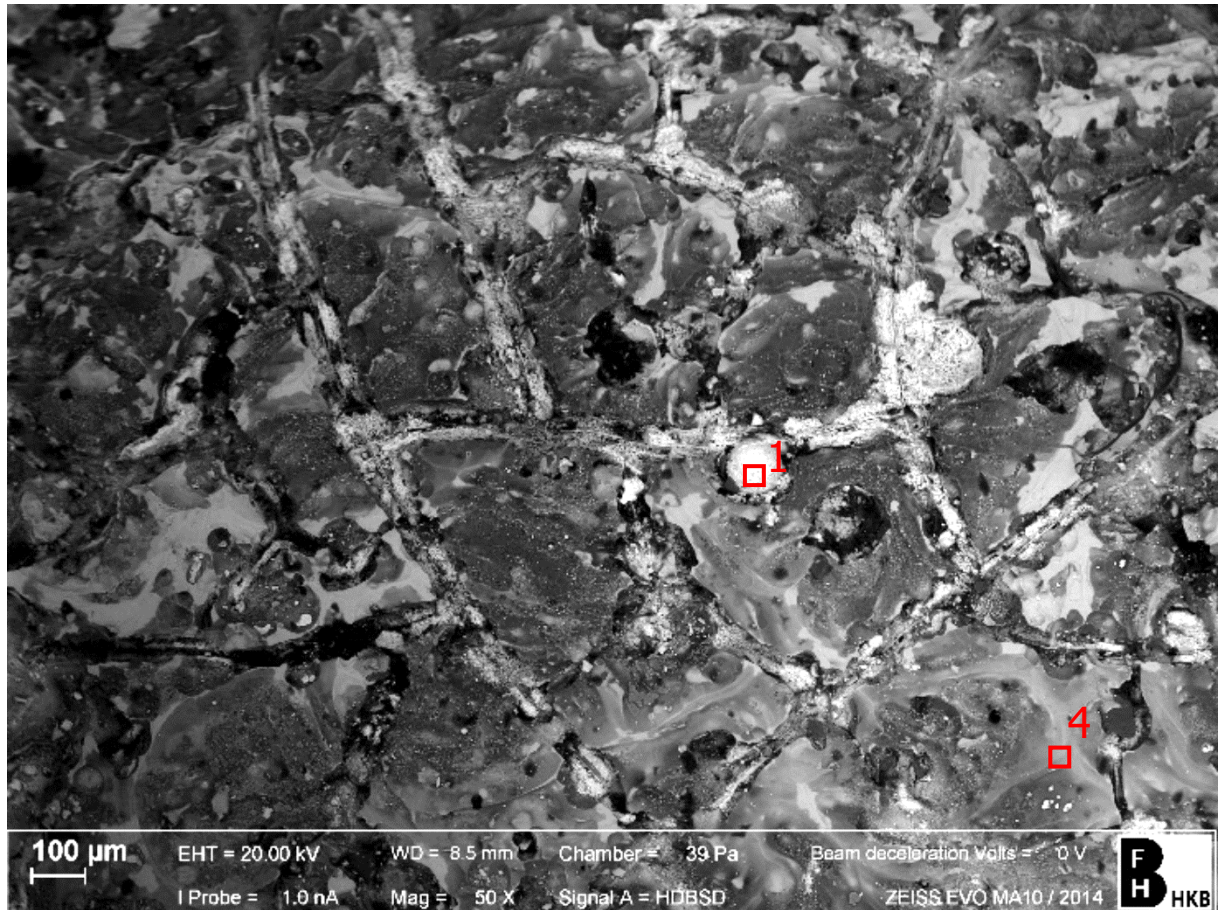


**Figure 124:** Localization of the SEM-EDS analysis areas  
© Nadim Scherrer, HKB

<sup>209</sup> A more in depth description of the technique can be found in Stuart, 2007, p.91-94.

### Analytical data

The data has been synthesized in the following pages. Some redundant results are not shown, but the numbers of the points have been maintained as they were determined during analysis.

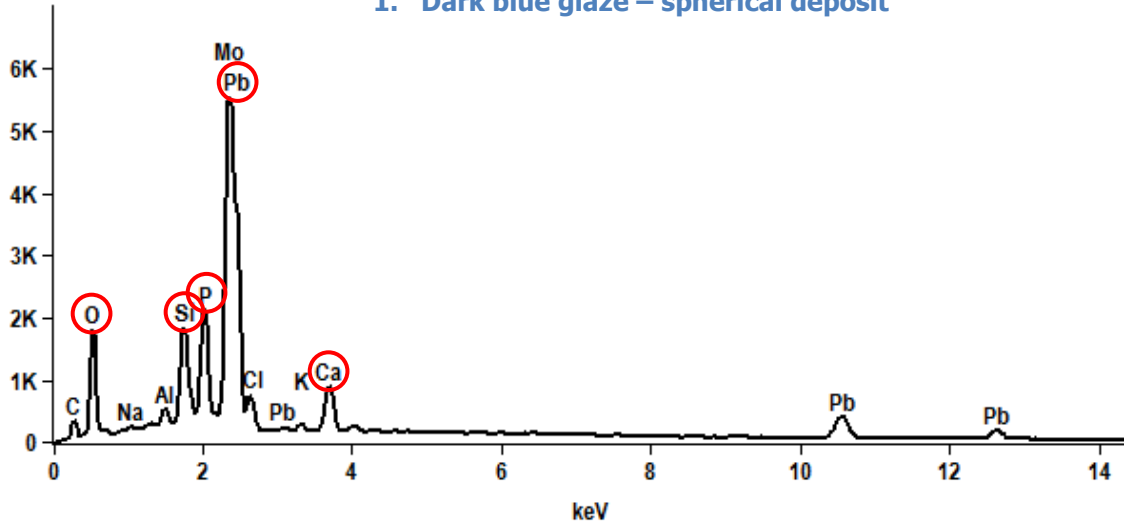


**Figure 125:** SEM picture of the dark blue glaze, 50x magnification. Localization of the analysis points.  
© Nadim Scherrer, HKB

Full scale counts: 5530

7216Blue\_50x20kV500pA40Pa\_pt1

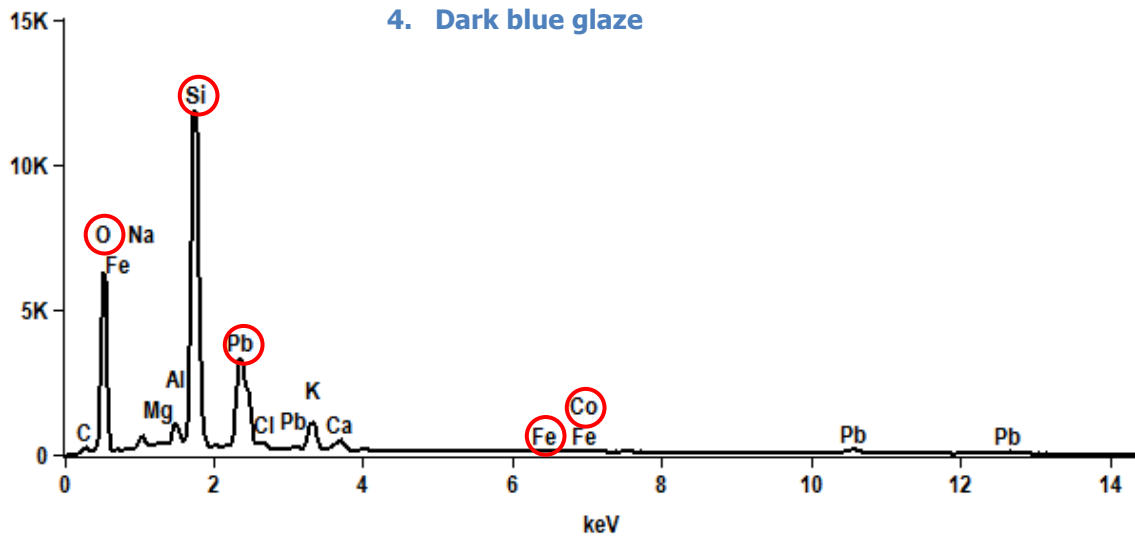
### 1. Dark blue glaze – spherical deposit

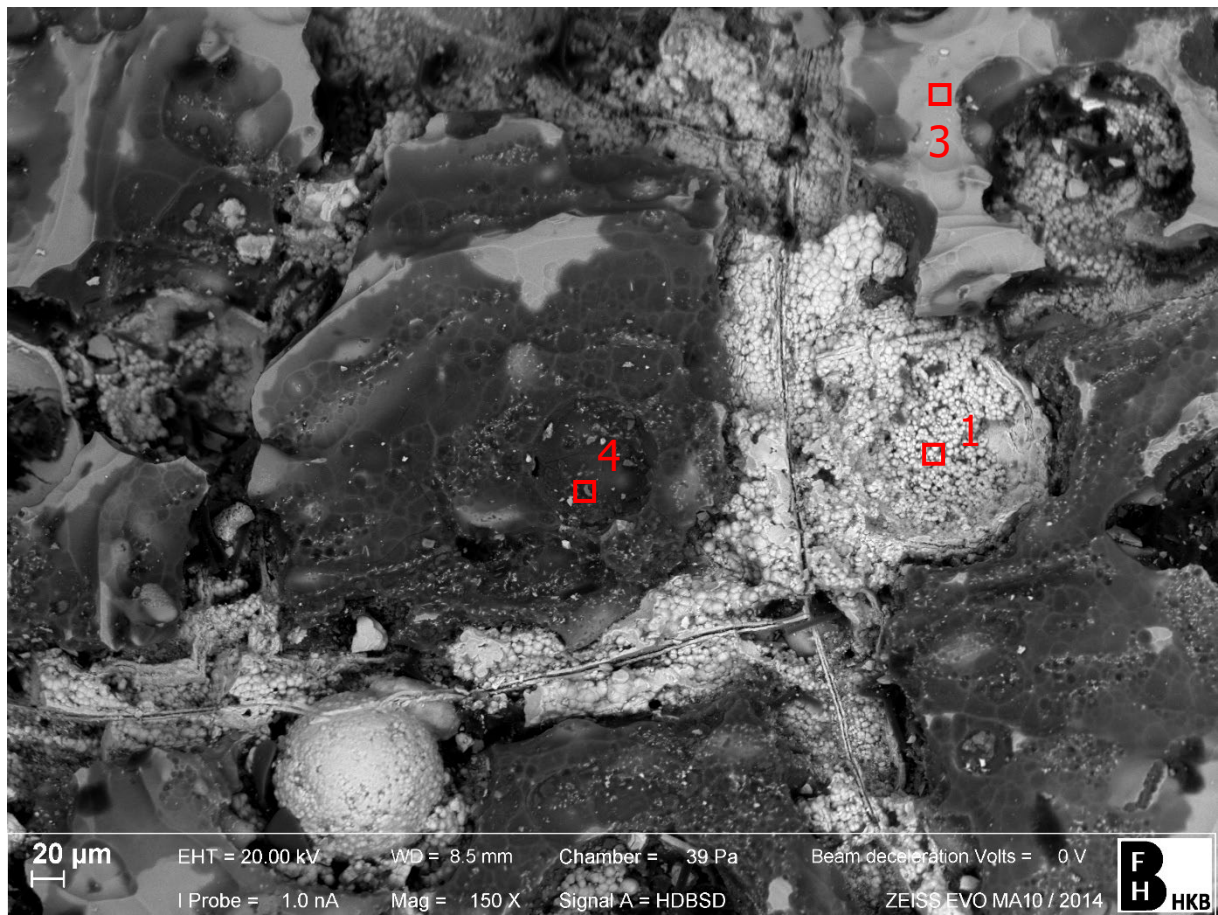


Full scale counts: 11883

7216Blue\_50x20kV500pA40Pa\_pt4

### 4. Dark blue glaze



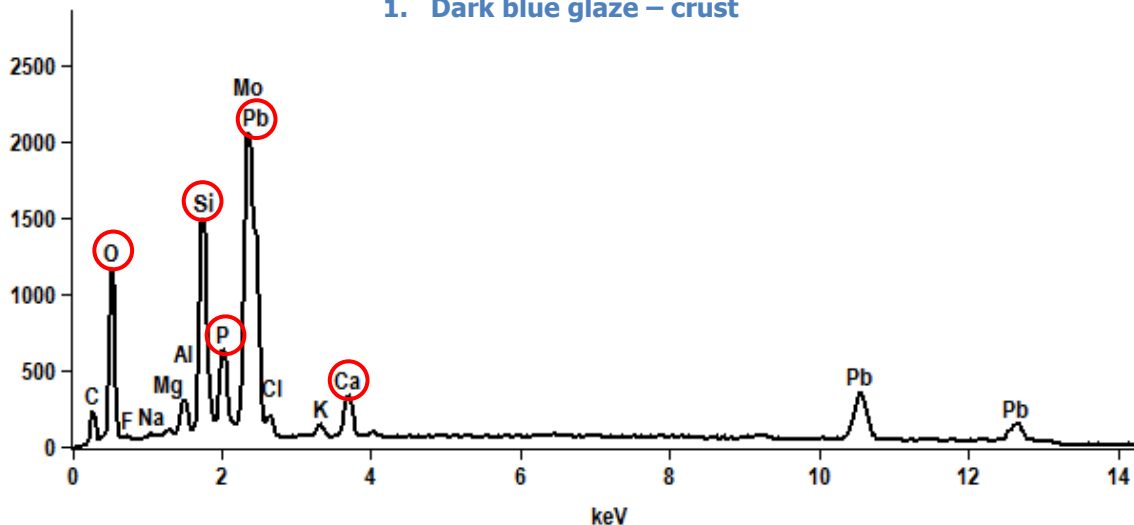


**Figure 126:** SEM picture of the dark blue glaze, 150x magnification. Localization of the analysis points.  
© Nadim Scherrer, HKB

Full scale counts: 2057

7216Blue\_150x20kv500pA40Pa\_pt1

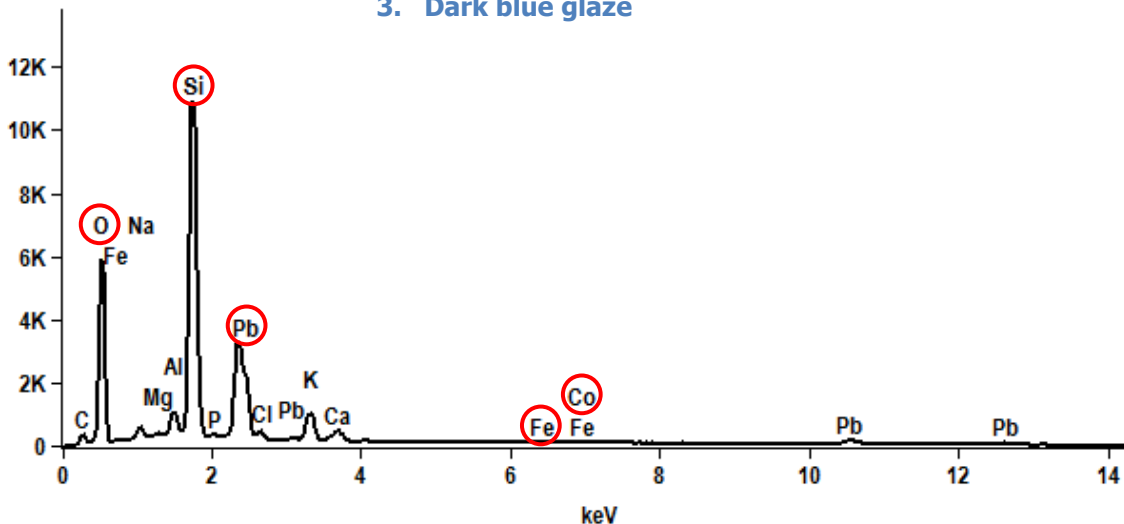
### 1. Dark blue glaze – crust



Full scale counts: 10903

7216Blue\_150x20kv500pA40Pa\_pt3

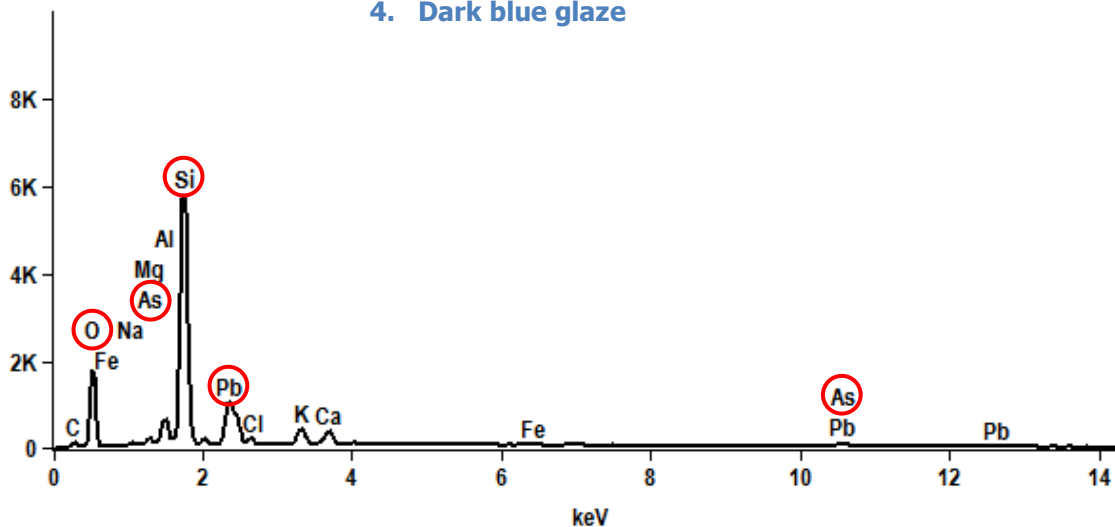
### 3. Dark blue glaze



Full scale counts: 5798

7216Blue\_150x20kv500pA40Pa\_pt4

### 4. Dark blue glaze



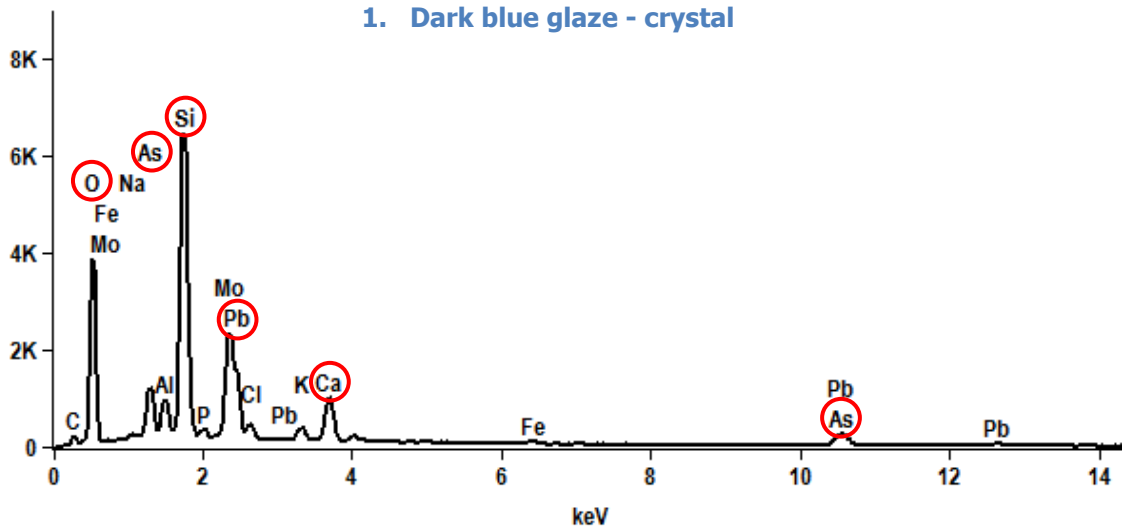


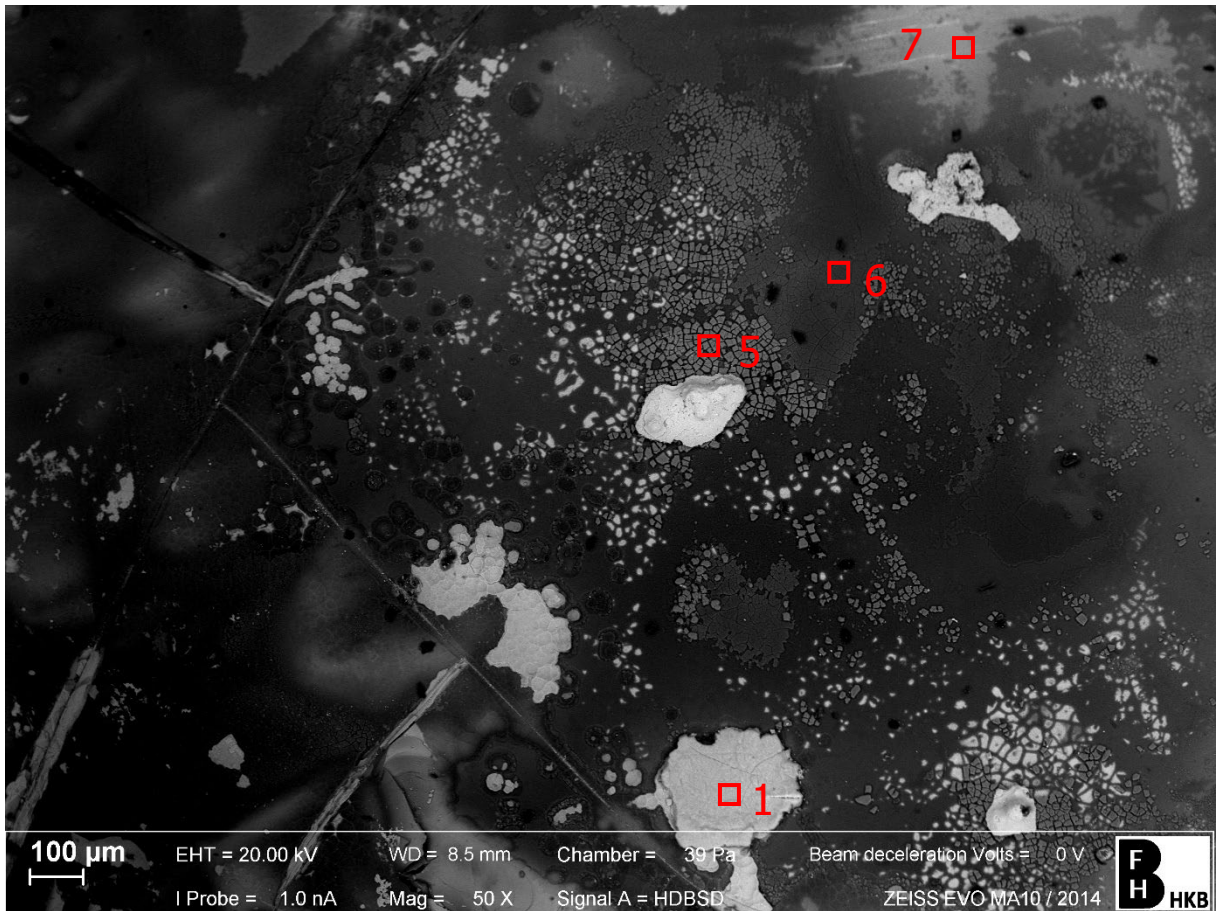
**Figure 127:** SEM picture of the dark blue glaze, 1000x magnification. Localization of the analysis point.  
© Nadim Scherrer, HKB

Full scale counts: 6456

7216Blue\_1000x20kV500pA40Pa\_pt1

### 1. Dark blue glaze - crystal



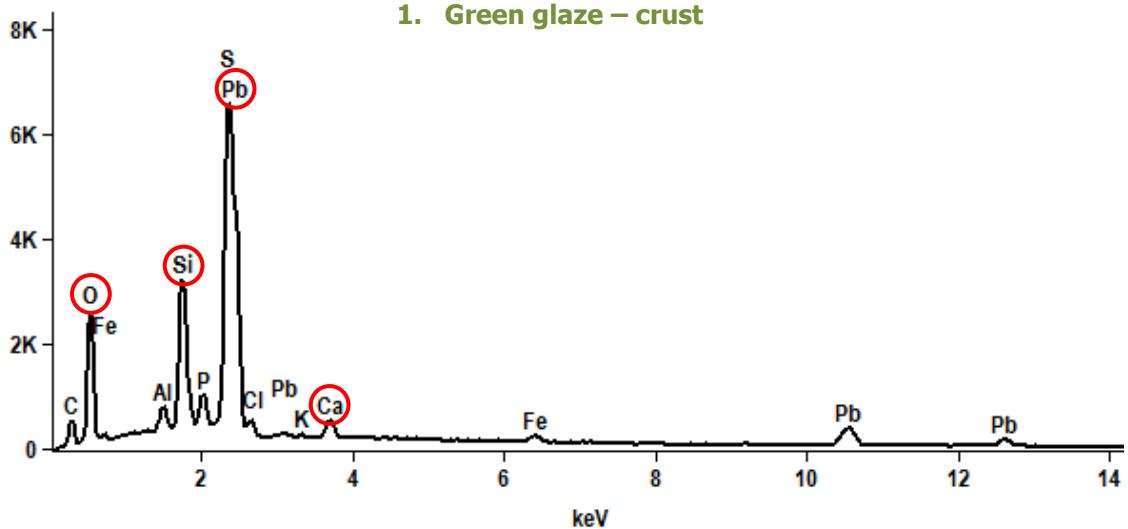


**Figure 128:** SEM picture of the green glaze, 50x magnification. Localization of the analysis points.  
© Nadim Scherrer, HKB

Full scale counts: 6575

7216G\_50x20kV1nA40Pa\_pt1

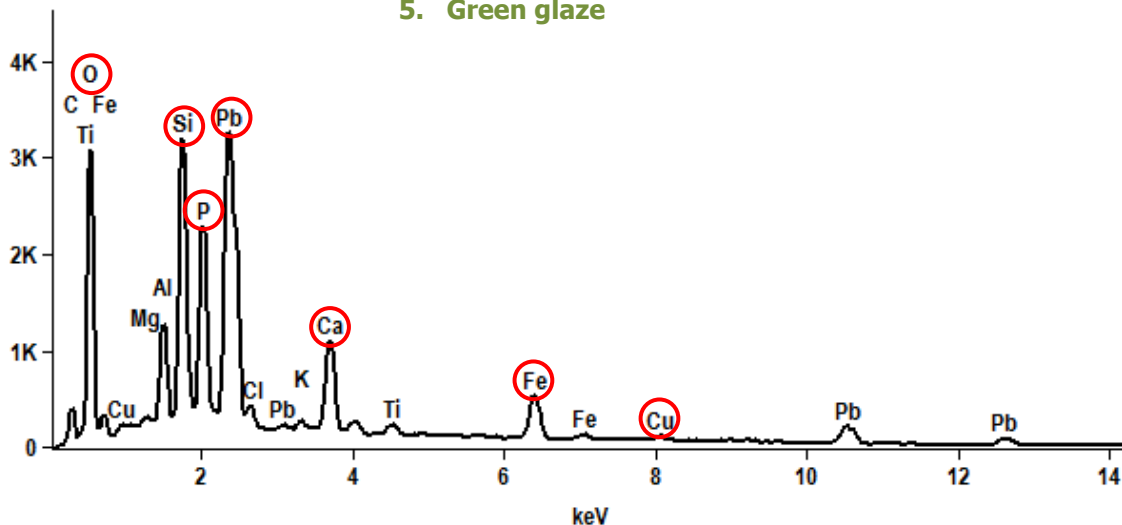
**1. Green glaze – crust**



Full scale counts: 3256

7216G\_50x20kV1nA40Pa\_pt5

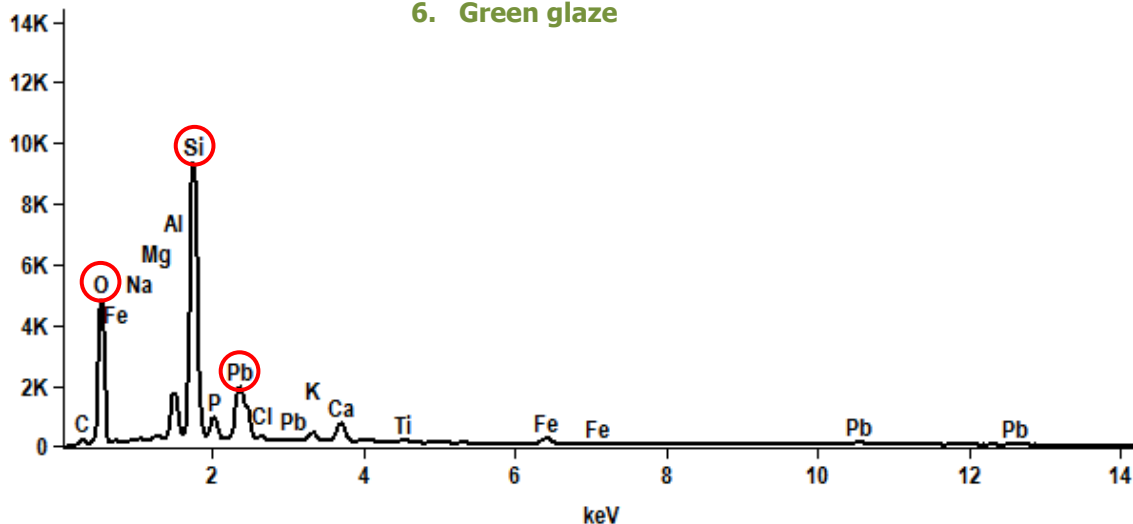
### 5. Green glaze



Full scale counts: 9361

7216G\_50x20kV1nA40Pa\_pt6

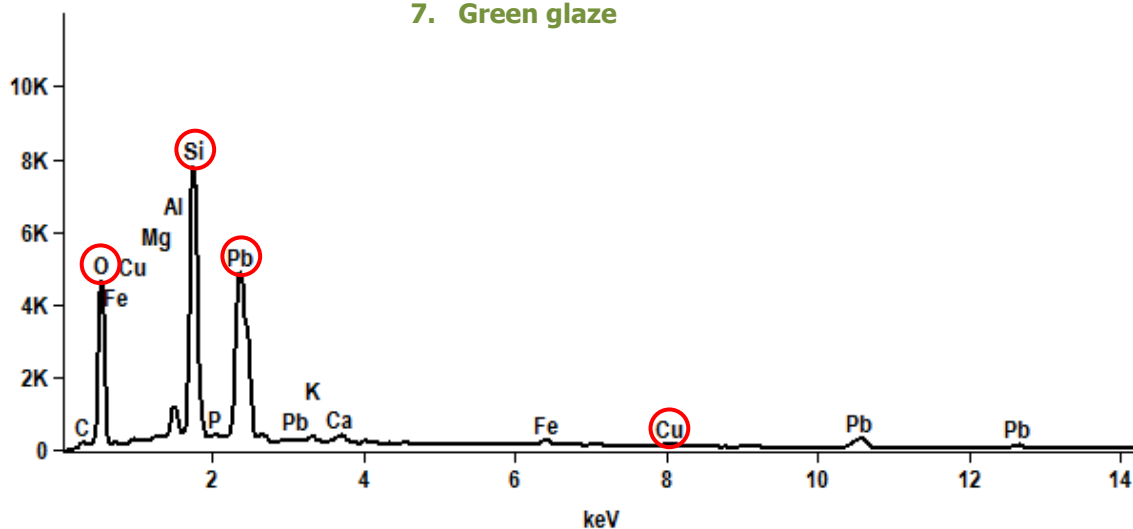
### 6. Green glaze

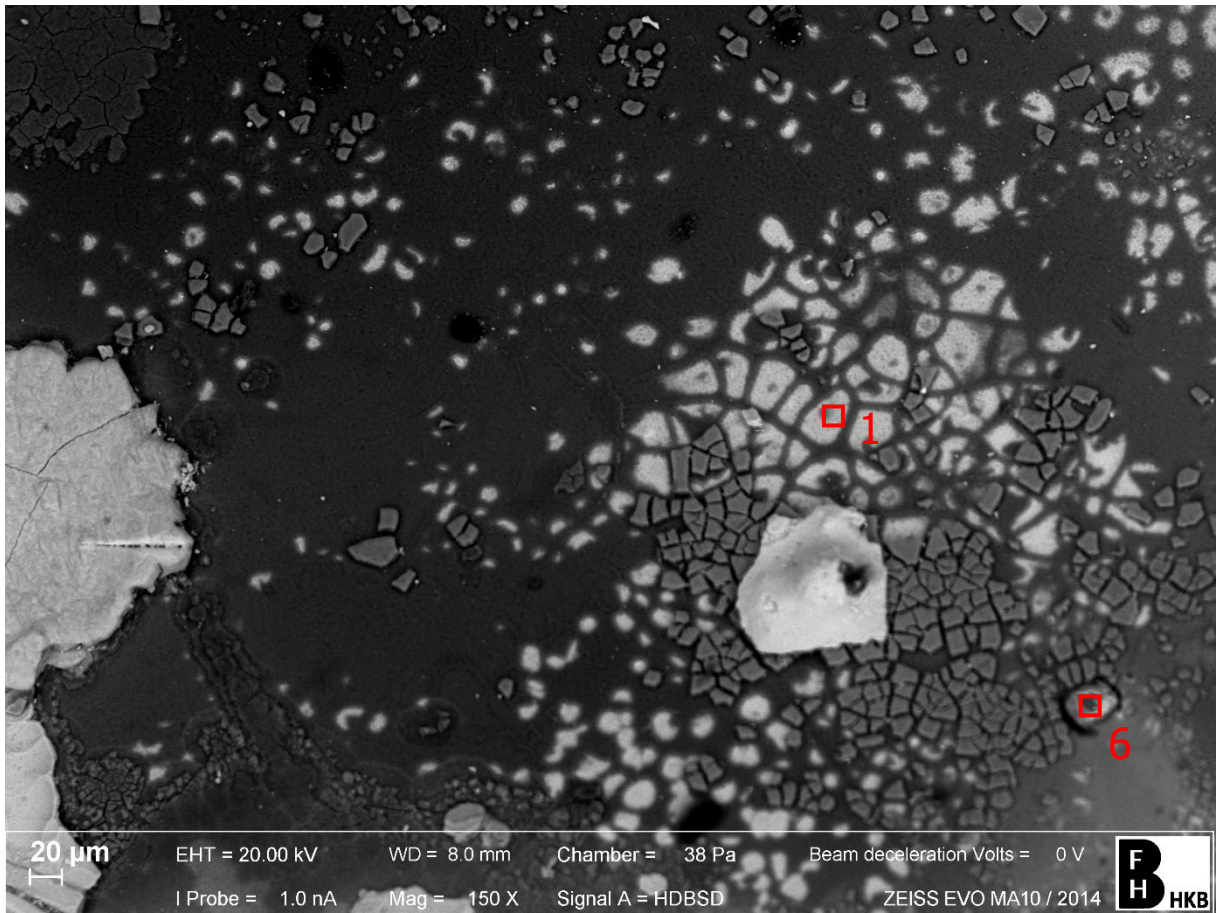


Full scale counts: 7797

7216G\_50x20kV1nA40Pa\_pt7

### 7. Green glaze



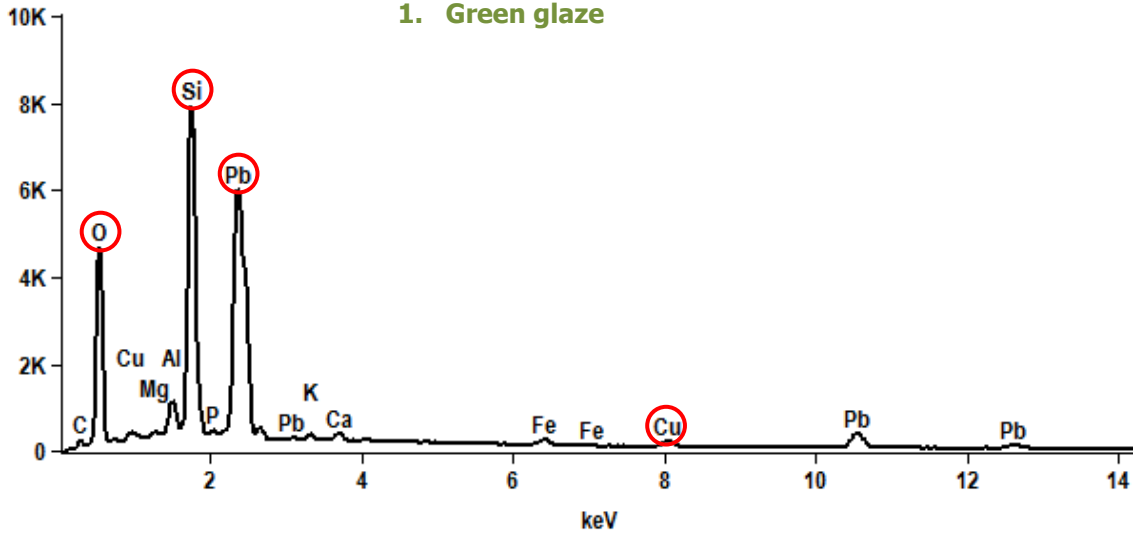


**Figure 129:** SEM picture of the green glaze, 150x magnification. Localization of the analysis points.  
© Nadim Scherrer, HKB

Full scale counts: 7915

7216G\_150x20kV1nA40Pa\_pt1

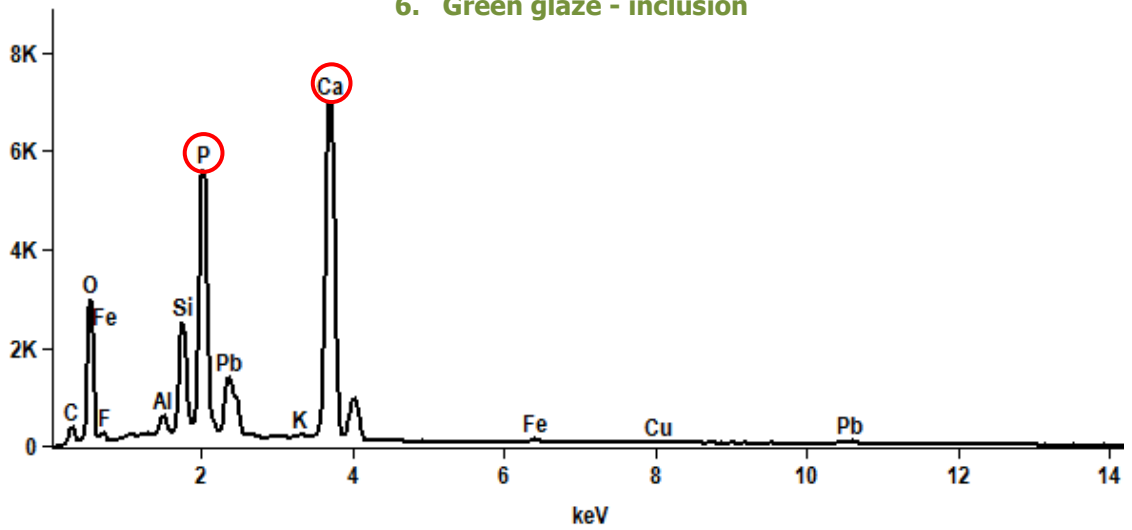
### 1. Green glaze

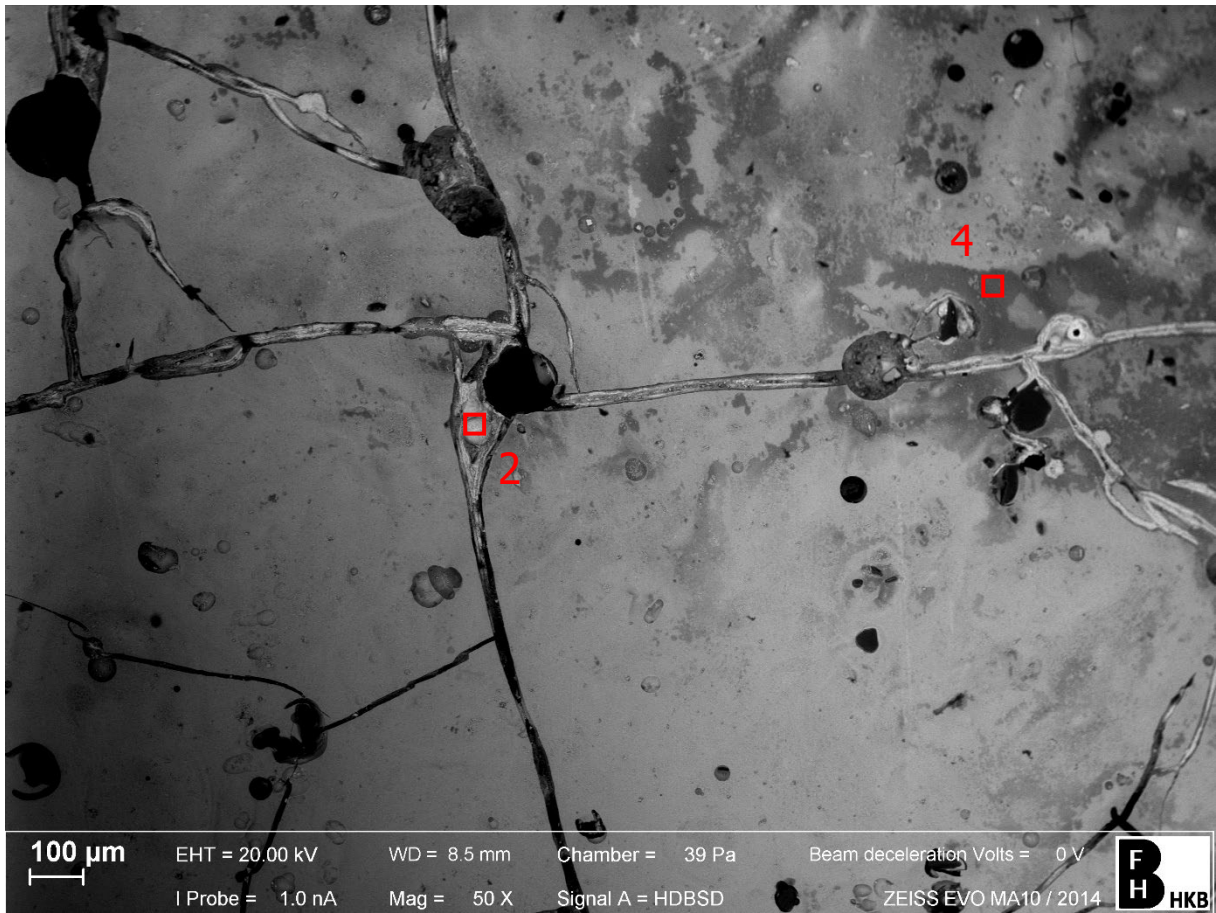


Full scale counts: 7002

7216G\_150x20kV1nA40Pa\_pt6

### 6. Green glaze - inclusion



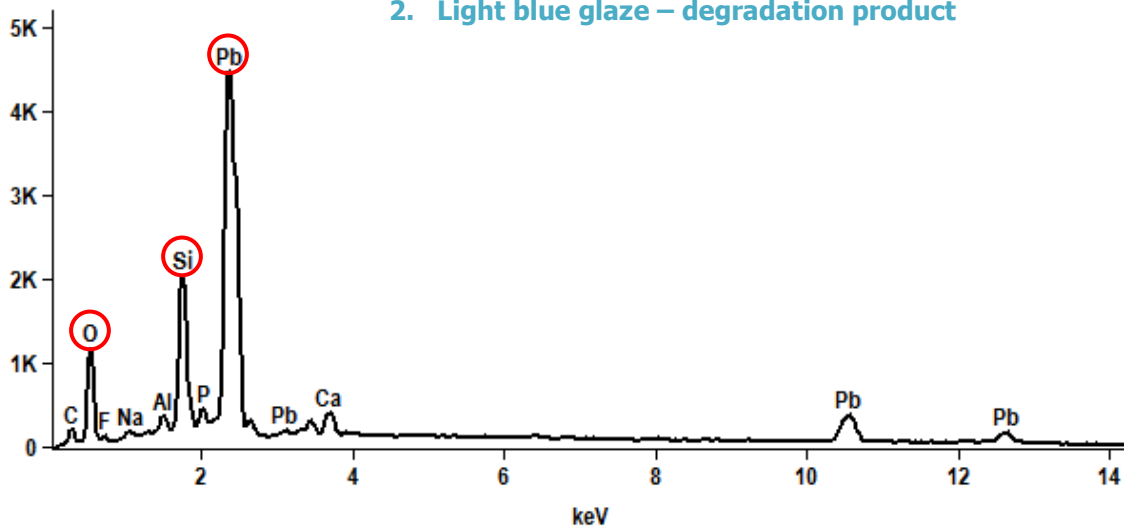


**Figure 130:** SEM picture of the light blue glaze, 50x magnification. Localization of the analysis points.  
© Nadim Scherrer, HKB

Full scale counts: 4467

7216IB\_50x20kV1nA40Pa\_pt2

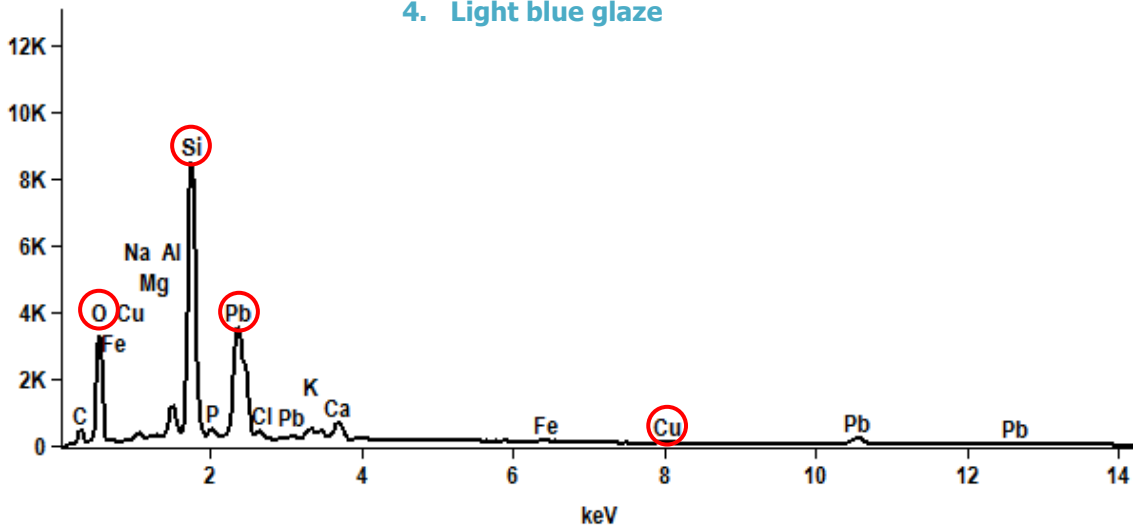
## 2. Light blue glaze – degradation product



Full scale counts: 8498

7216IB\_50x20kV1nA40Pa\_pt4

## 4. Light blue glaze



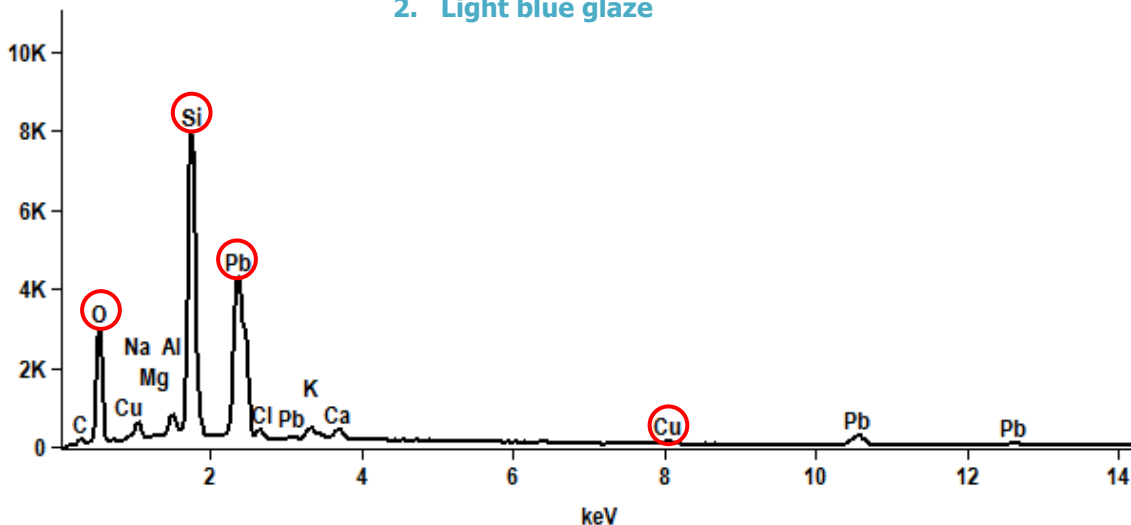


**Figure 131:** SEM picture of the light blue glaze, 150x magnification. Localization of the analysis points.  
© Nadim Scherrer, HKB

Full scale counts: 7950

7216IB\_150x20kV1nA40Pa\_pt2

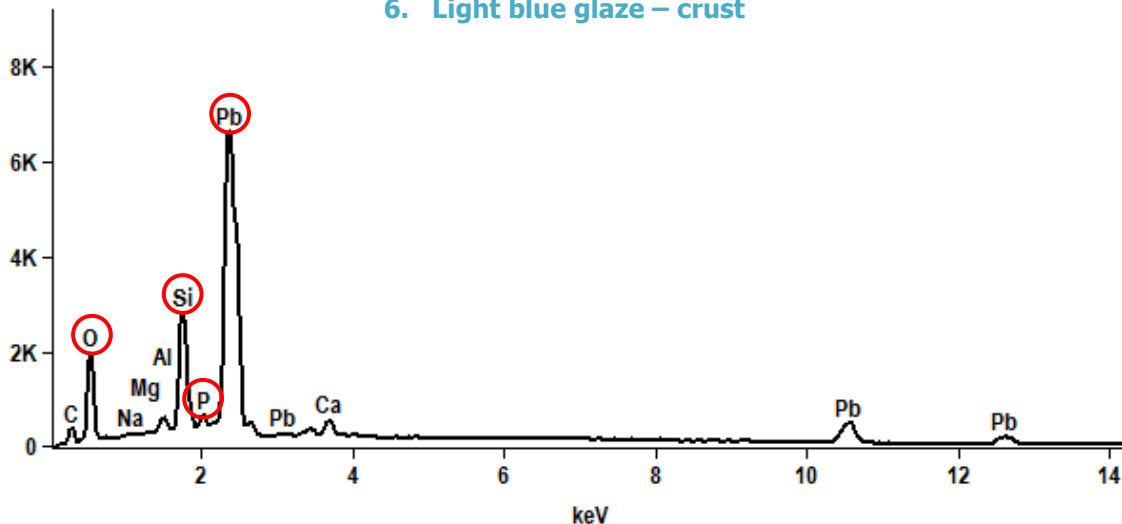
### 2. Light blue glaze



Full scale counts: 6611

7216IB\_150x20kV1nA40Pa\_pt6

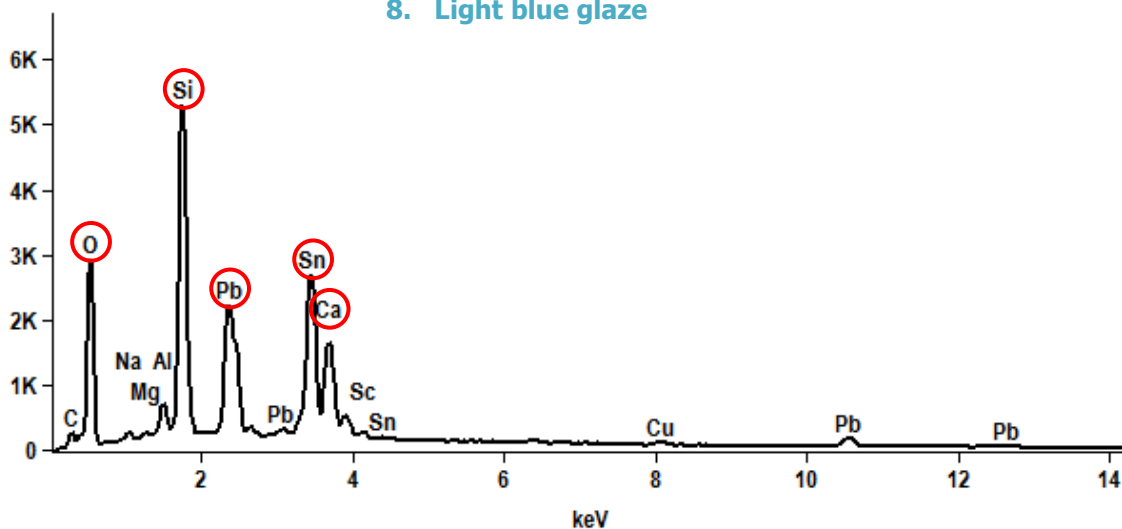
### 6. Light blue glaze – crust

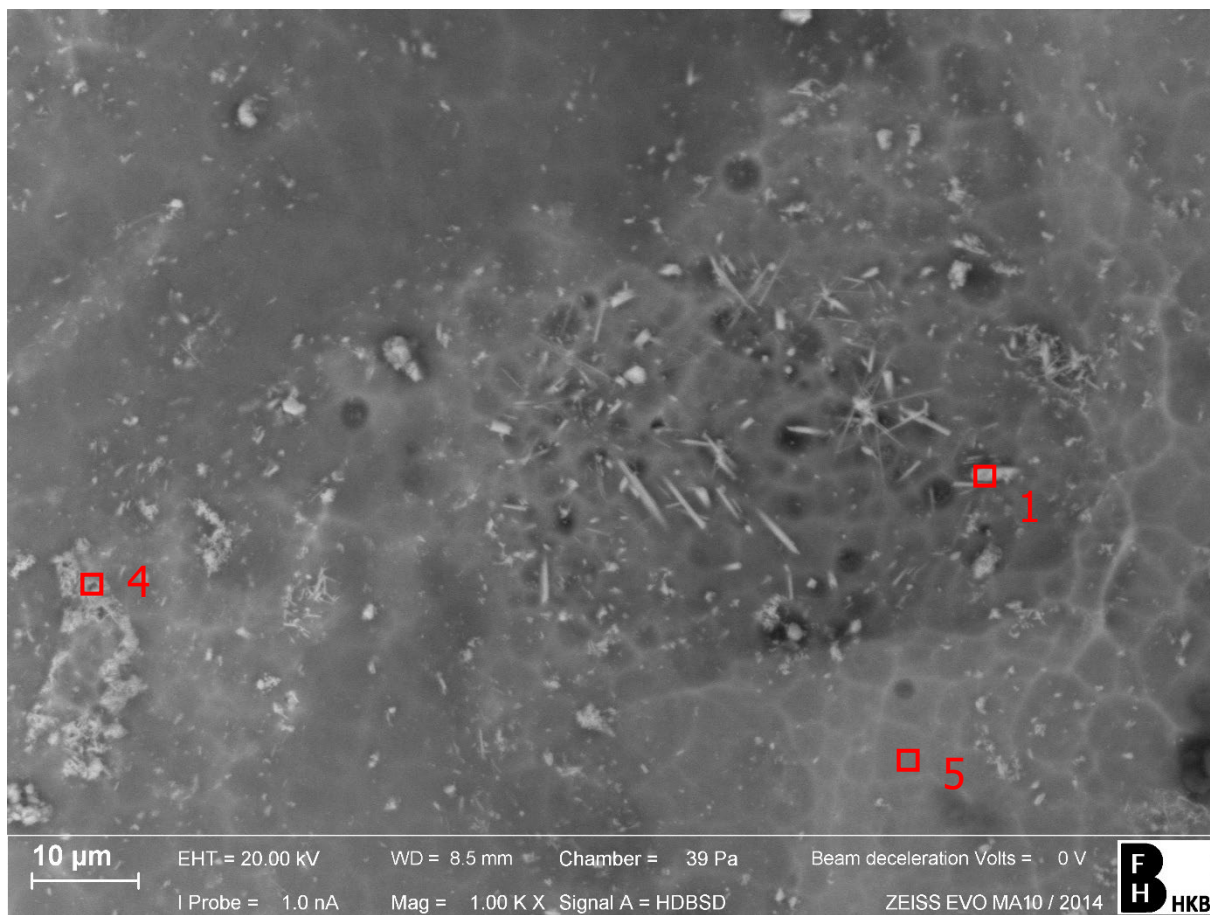


Full scale counts: 5291

7216IB\_150x20kV1nA40Pa\_pt8

### 8. Light blue glaze



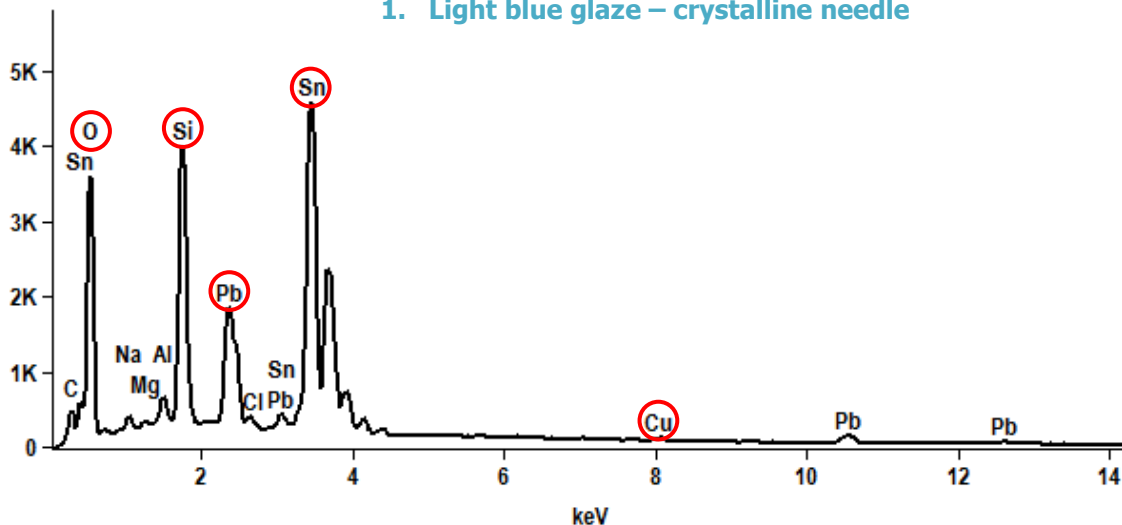


**Figure 132:** SEM picture of the light blue glaze, 1000x magnification. Localization of the analysis points.  
© Nadim Scherrer, HKB

Full scale counts: 4580

7216IB\_1000x20kV1nA40Pa\_pt1

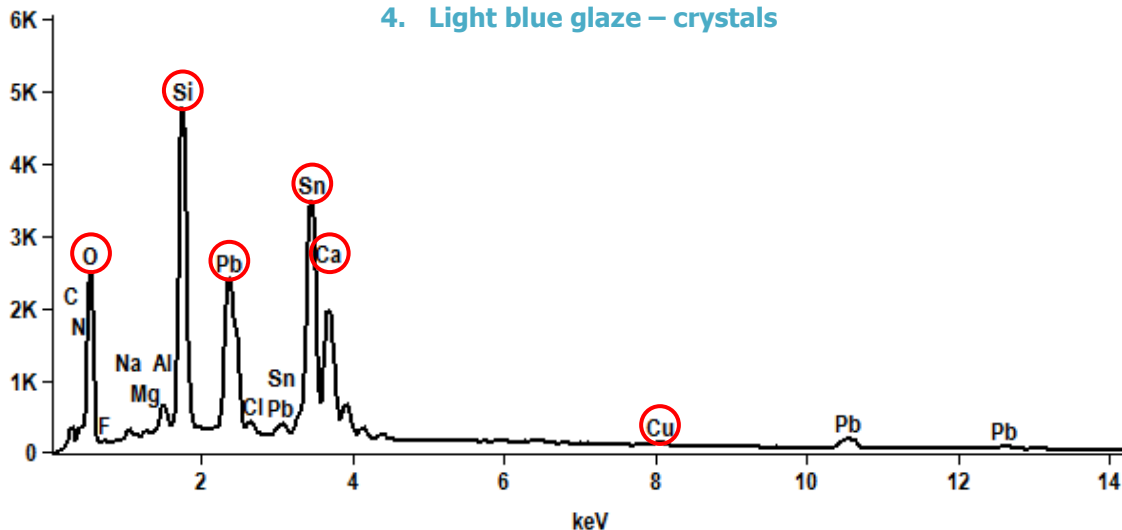
### 1. Light blue glaze – crystalline needle



Full scale counts: 4784

7216IB\_1000x20kV1nA40Pa\_pt4

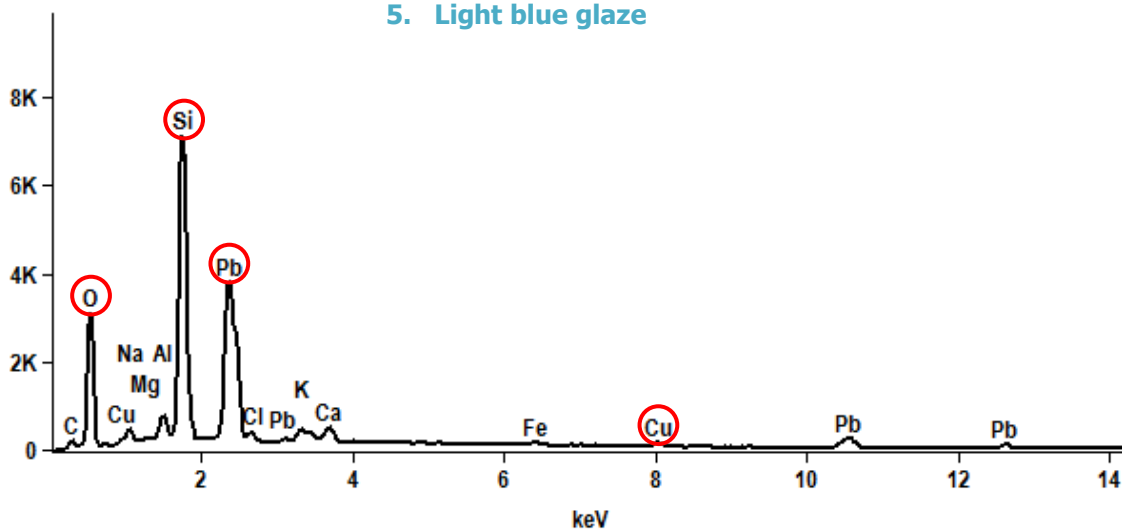
### 4. Light blue glaze – crystals

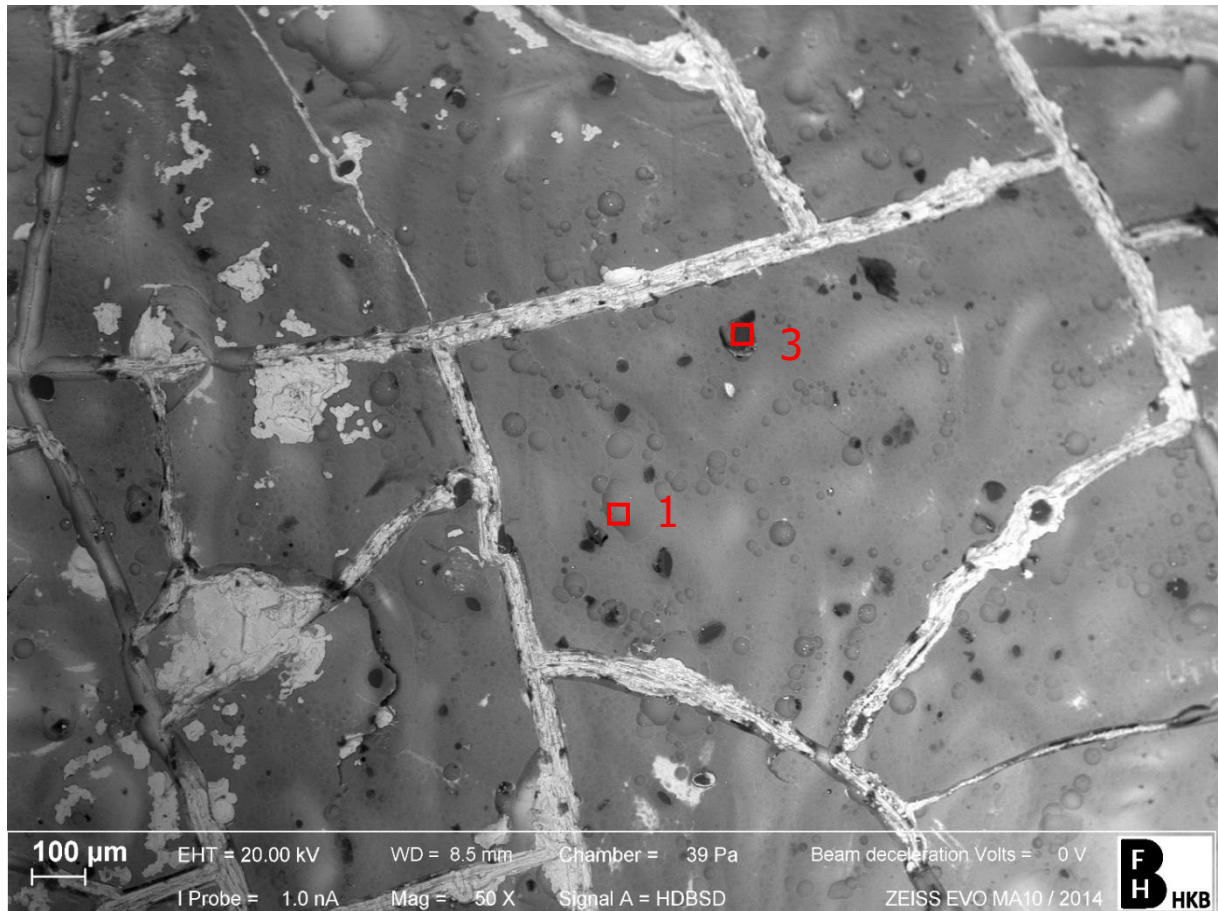


Full scale counts: 7116

7216IB\_1000x20kV1nA40Pa\_pt5

### 5. Light blue glaze



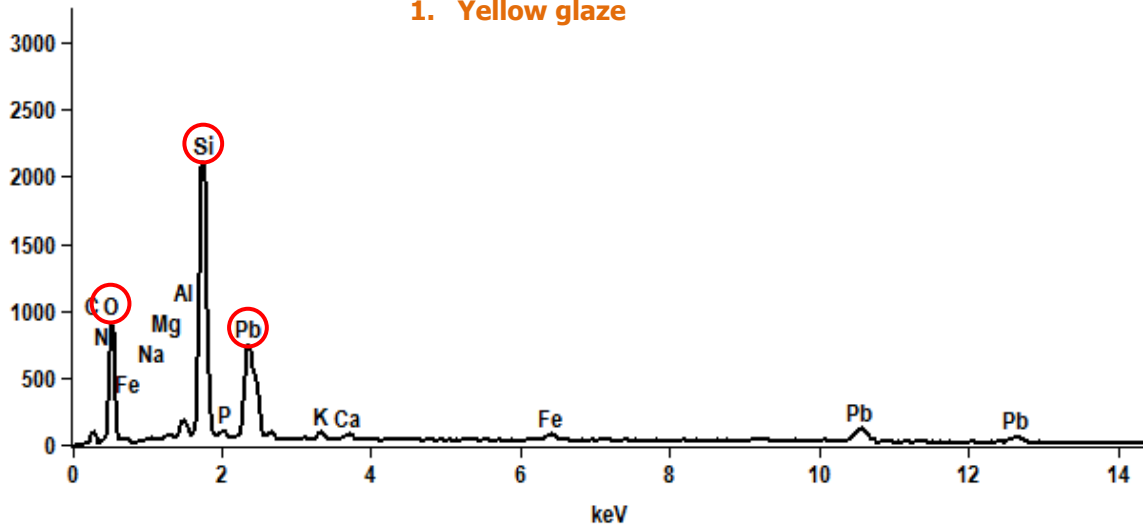


**Figure 133:** SEM picture of the yellow glaze, 50x magnification. Localization of the analysis points.  
© Nadim Scherrer, HKB

Full scale counts: 2112

7216Yel\_50x20kV1nA40Pa\_pt1

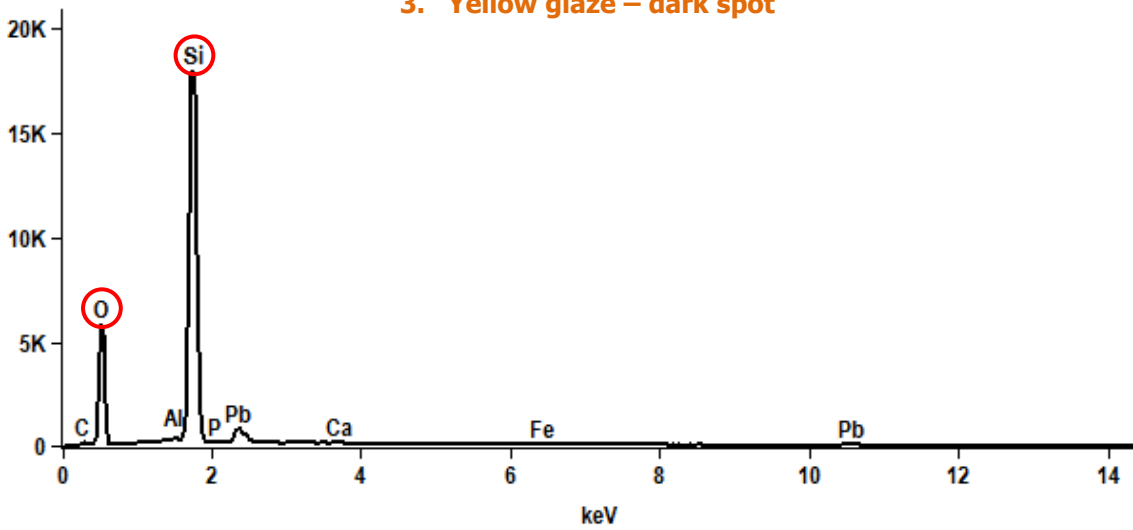
### 1. Yellow glaze

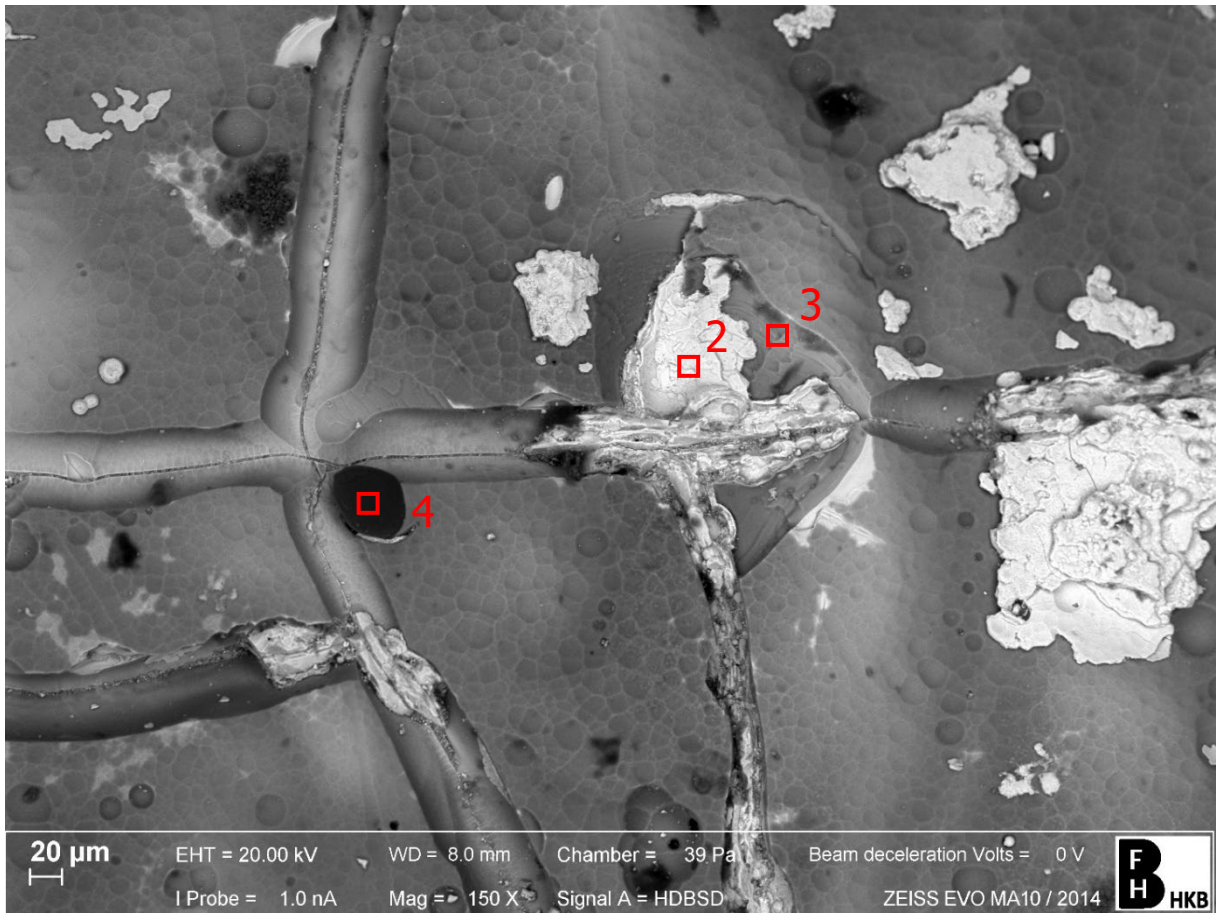


Full scale counts: 17957

7216Yel\_50x20kV1nA40Pa\_pt3

### 3. Yellow glaze – dark spot



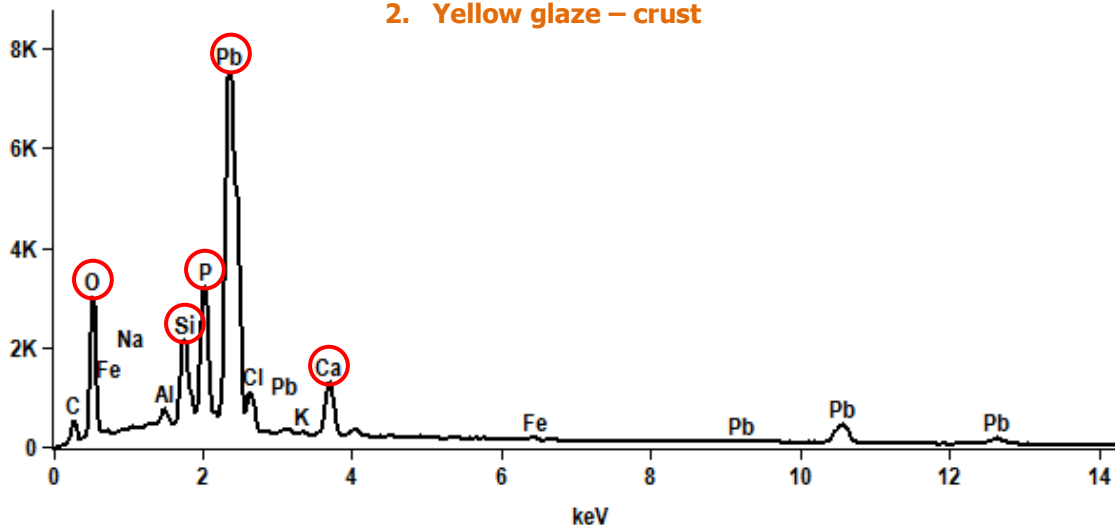


**Figure 134:** SEM picture of the yellow glaze, 150x magnification. Localization of the analysis points.  
© Nadim Scherrer, HKB

Full scale counts: 7517

7216Yel\_150x20kV1nA40Pa\_pt2

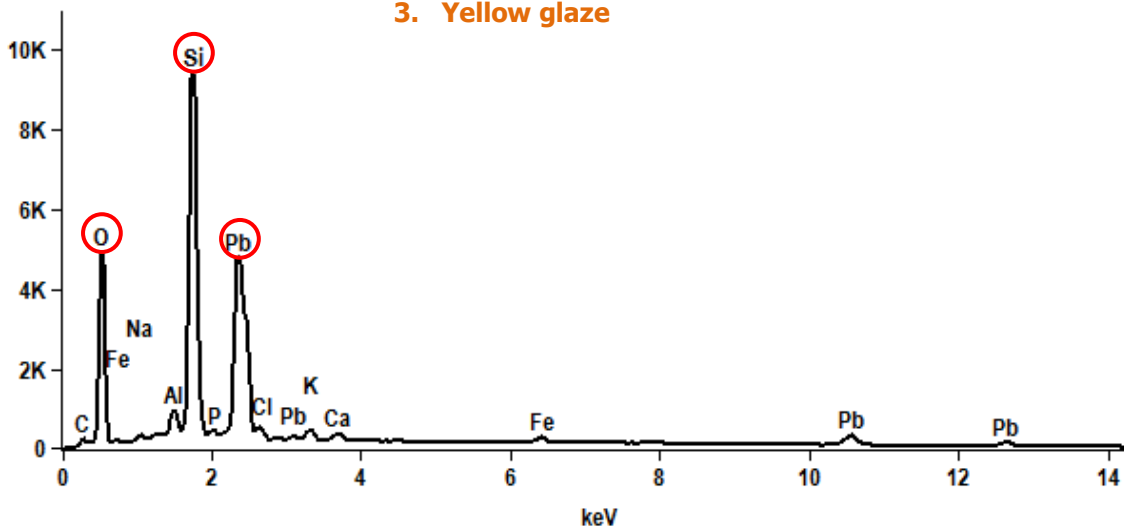
### 2. Yellow glaze – crust



Full scale counts: 9411

7216Yel\_150x20kV1nA40Pa\_pt3

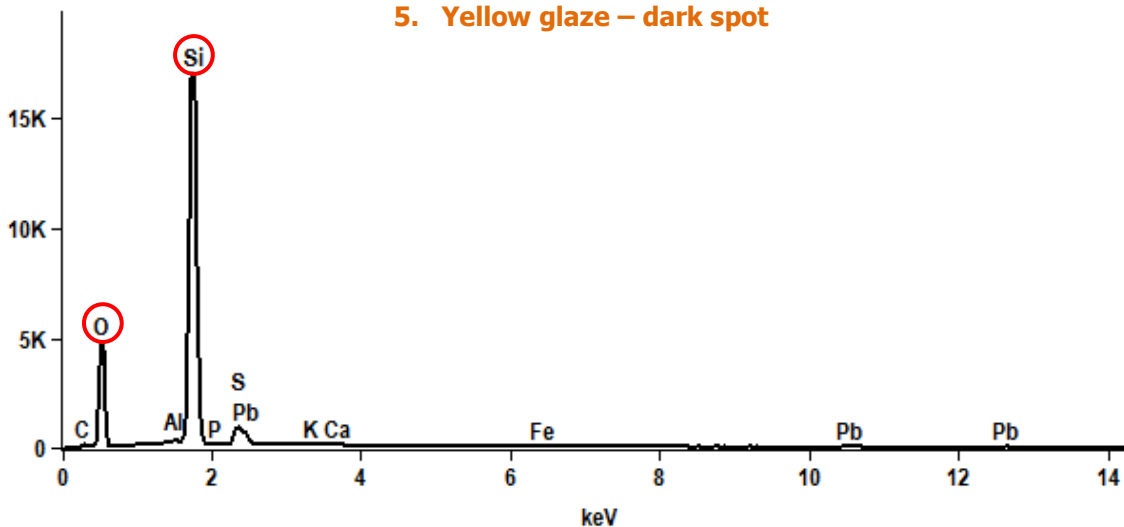
### 3. Yellow glaze



Full scale counts: 17070

7216Yel\_150x20kV1nA40Pa\_pt5

### 5. Yellow glaze – dark spot



## Interpretation of the results

The colored glazes in general are composed of **silica** (Si), **oxygen** (O) and **lead** (Pb). They seem to all contain impurities that are not intentionally associated to coloring, such as **iron** (Fe), **aluminum** (Al), **magnesium** (Mg) and **calcium** (Ca). These can be linked to the fabrication or burial context.

Concerning the **arsenic** (As) found in the glaze during the XRF analysis, it was only found in the dark blue color during SEM-EDS. It appeared as minuscule flakes. During analysis, it always showed up as "possible" in all glaze colors, but rarely showed up in the graphs.

The **crusts and degradation products** generally exhibited a much higher lead content. We also sometimes find higher quantities of phosphorous (P) and calcium (Ca). This could indicate that the corrosion products and deposits are **calcium phosphate** ( $\text{Ca}_3(\text{PO}_4)_2$ ) and **lead (II) phosphate** ( $\text{Pb}_3(\text{PO}_4)_2$ ). These products are always localized in the cracks and pinholes in the glazes, as it seems these were the starting points for lixiviation.

In the **dark blue glaze**, very small amounts of **cobalt** (Co) were detected as the colorant. The basic glaze composition does not vary significantly from the other colors examined. We can also see in the images just how much this color of glaze is much more degraded than the others.

In the **green glaze**, we identified **copper** (Cu) as the coloring agent, in very small quantities again.




In the **light blue glaze**, **copper** was also found, as well as **tin** (Sn). The tin was not found in every point analyzed, as it is in a suspended crystalline, sometimes needle-like form in the glaze. Its presence is generally associated with a higher content of calcium (Ca).

Finally, in the **yellow glaze**, no particular colorant was found. Some dark spots were observed, and identified as **silicon dioxide** (Si-O<sub>2</sub>).

## 10. Complete condition reports

### 10.1 ARCH 7216-94 and 7217-94

#### Structural alterations

<p><b>Break:</b> 29 fragments were originally attributed to the two vessels. Upon closer study, 14 belong to 7216, 10 to 7217, and 5 are not attributed to any. The breaks generally occurred between the base and the walls of the ceramic. The break edges are jagged, but not particularly eroded. Where there are imprinted appliques, they sometimes broke from the vessel walls, and the external layer of the object is missing (<b>Fig. 135</b>).</p>	 <p><b>Figure 135:</b> Missing part of the applique layer</p>
<p><b>Lacunae:</b> Object 7216 is approximately 65% complete, with the largest lacuna being the base. Object 7217 is probably 30% complete.</p>	
<p><b>Glaze lacunae:</b> The glaze has flaked off around break edges and on some impact points, mostly on the rim. The dark blue glaze has flaked off significantly in some areas, and is very cracked and blistered.</p>	 <p><b>Figure 136:</b> Fragment with significant lacunae in the dark blue glaze</p>
<p><b>Crazing:</b> The glazes are all crazed. The dark blue and light blues have deeper and larger cracks between flakes (see <i>Documentation of the glaze</i>, on p.134). Soil had penetrated the crazing and makes the lines more visible.</p>	 <p><b>Figure 137:</b> Very apparent crazing on the edge of the vessel</p>

**Separation:** Fissures are visible on the break edges, where the decors have been adhered to the vessel during fabrication. These most likely appeared during drying or firing.



*Figure 138: Separation between the applique and the underlying ceramic layer*

### Surface alterations

**Deposits:** The deposits are similar on all objects, and are described extensively on pages 26 and 27.

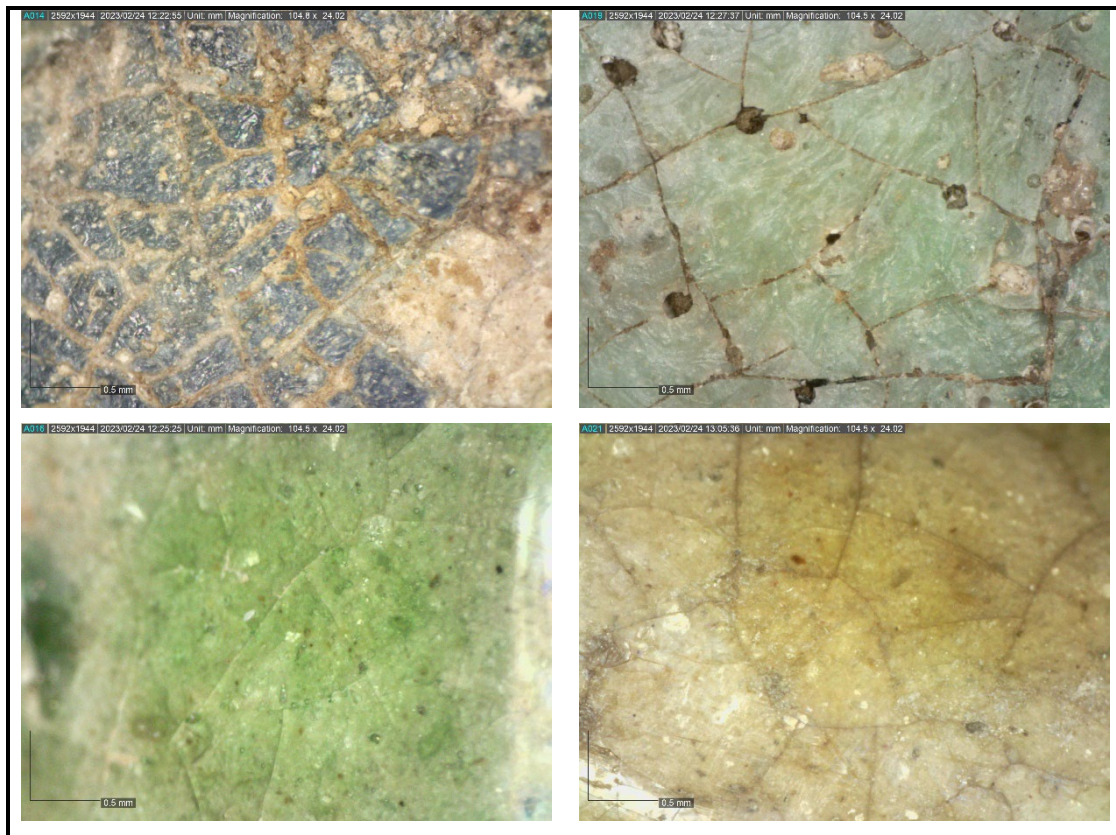
**Iridescence:** The glaze appears iridescent in some places, mostly on the green glaze.



*Figure 139: Slight iridescence on the green glaze*

**Lixiviation and corrosion:** The glazes were chemically altered by their environment, which lead to dulling of the surface and the formation of degradation products on the surface.


## Documentation of the glaze




**Table 14:** Photography under magnification of the glaze colors of objects 7216 and 7217

## 10.2 ARCH 7218-94

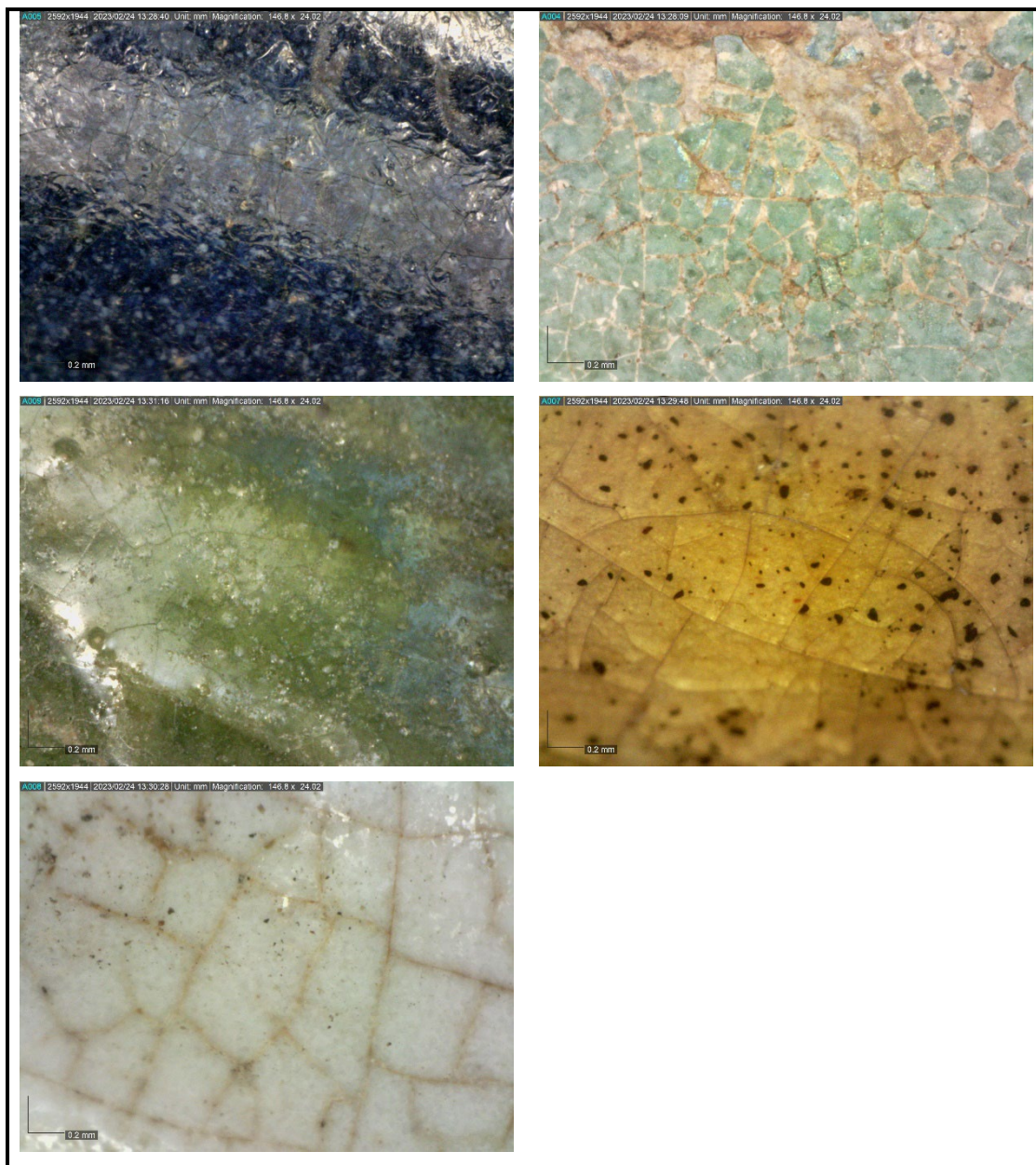
### Structural alterations

<p><b>Break:</b> This object is broken in 5 sherds. The breaks on the base have occurred in a star pattern. The elements added to the base have generally broken at their juncture.</p>	 <p><i>Figure 140: Star-shaped break of the base of the object</i></p>
<p><b>Lacunae:</b> The complete shape of the object is unknown and the loss percentage neither.</p>	
<p><b>Glaze lacunae:</b> The glaze has flaked off around break edges. There are a few losses linked to poor glaze adhesion during fabrication.</p>	
<p><b>Crazing:</b> The glazes are all crazed and the cracks are lightly soiled. The crazing is not particularly important. The light blue and the white glaze colors have larger cracks which are also more soiled. (see <i>Documentation of the glaze</i>, on p.136)</p>	

### Surface alterations

<p><b>Deposits:</b> There is a faint light gray to brown soiling present on the inside and the sunken-in parts of the fragments. It is very thin and has penetrated the crazing of the glaze in some places. It is quite adherent to the surface and cohesive.</p>	 <p><i>Figure 141: Deposits on a sherd</i></p>
--	--



## Documentation of the glaze



**Table 15:** Photography under magnification of the glaze colors of object 7218

### 10.3 ARCH 7219-94

#### Structural alterations

<p><b>Break:</b> This object is broken in 5 sherds. The edges are hardly eroded.</p>	 <p><i>Figure 142: Star-shaped break of object 7219</i></p>
<p><b>Lacunae:</b> The circular element is approx. 90% complete, but the archaeological profile is unknown and the percentage of lacunae of the object overall cannot be estimated.</p>	 <p><i>Figure 143: Glaze lacunae on the edges of the sherds</i></p>
<p><b>Glaze lacunae:</b> The glaze has flaked off around break edges and on some impact points around the edges of the object. There are some lacunae or holes linked to poor glaze adhesion before firing. They are recognizable by their rounded edges.</p>	
<p><b>Abrasions:</b> The glazed surface has become dull in some areas because of micro-scratches to its surface. This is especially the case on the edge of the rim.</p>	
<p><b>Crazing:</b> The glazes are all crazed and the cracks are lightly soiled. The crazing is not particularly significant.</p>	

## Surface alterations

**Deposits:** The deposits are generally the same as described for the other objects. On one fragment, the deposits are particularly thick and very hard. They seem to be of similar nature than the thinner greyish deposits.



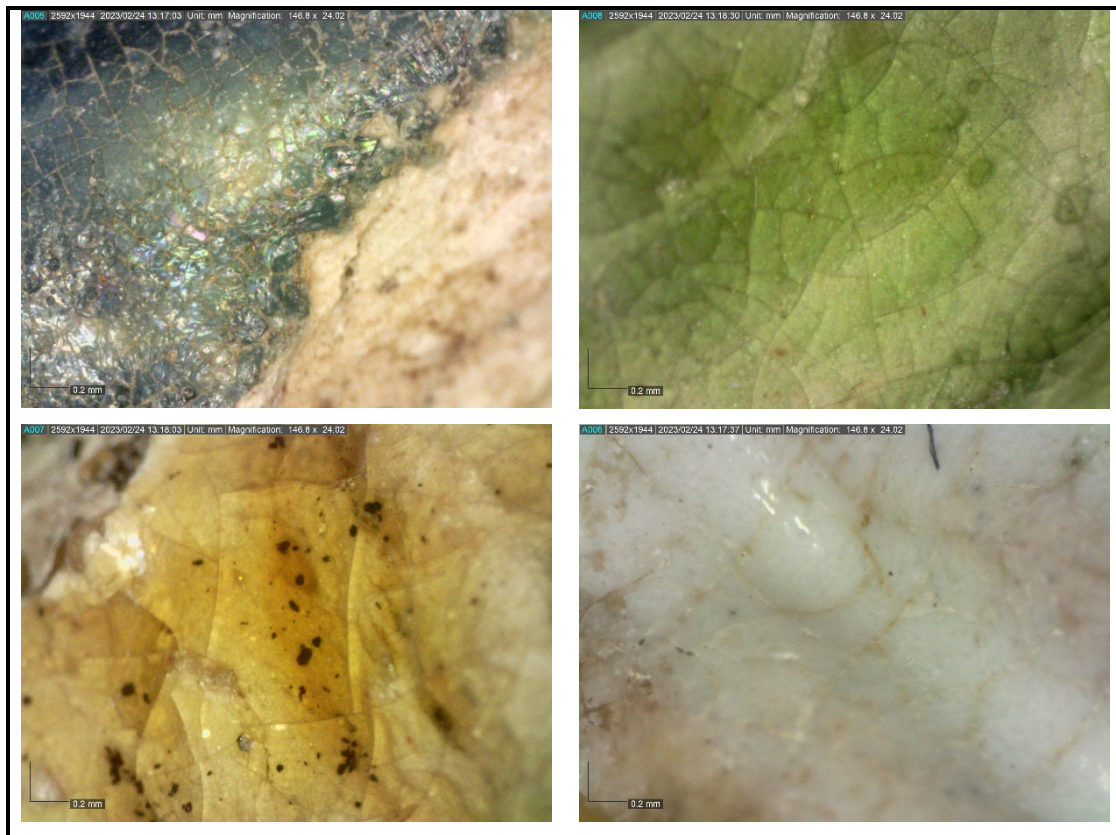
*Figure 144: Thick deposits on one sherd*

**Iridescence:** Iridescence is visible on some parts of the glaze. After cleaning, more extensive iridescence is visible where deposits used to lie. It is not at an advanced stage and is caused by chemical degradation.



*Figure 145: Slight iridescence of the glaze (left)*



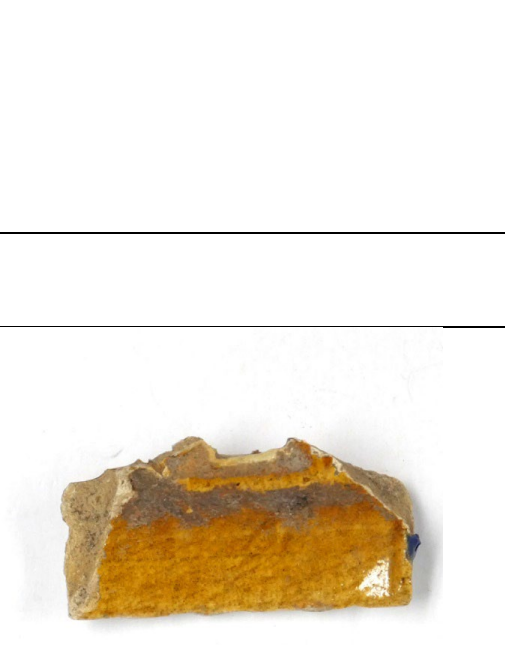
## Documentation of the glaze




*Table 16: Photography under magnification of the glaze colors of object 7219*

## 10.4 ARCH 7220-94

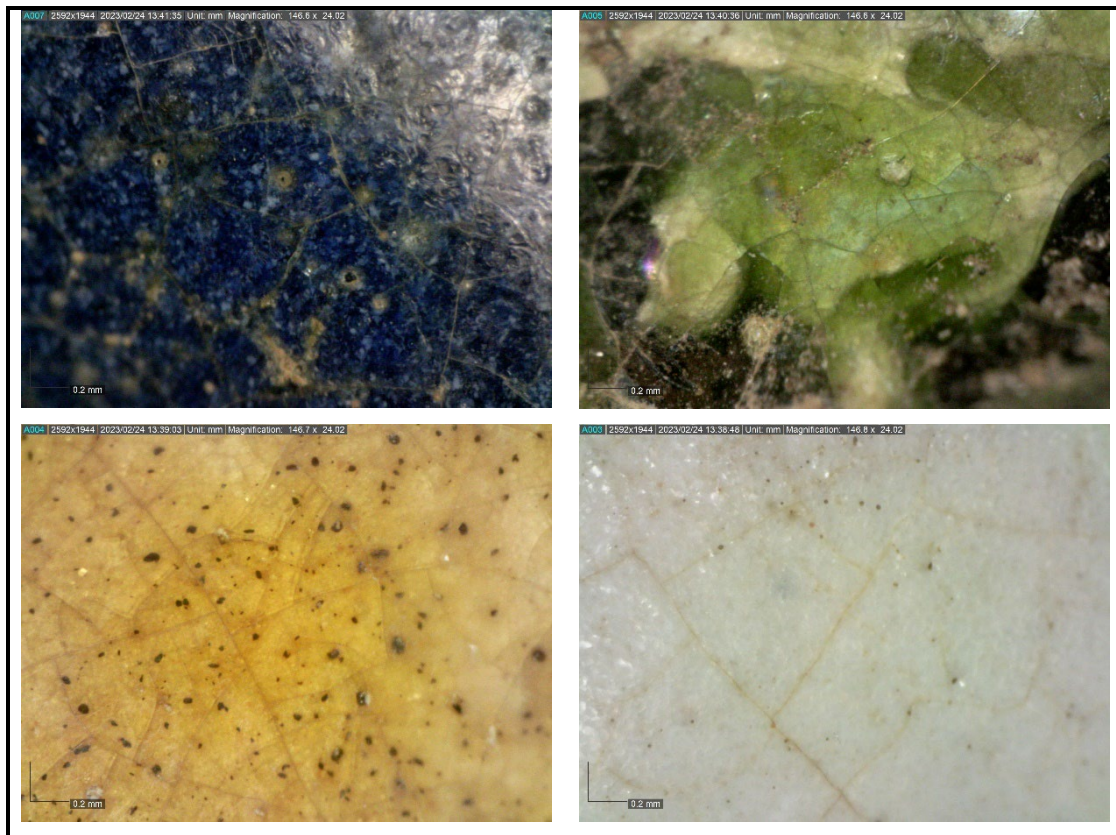
### Structural alterations

<p><b>Break:</b> The object is broken in 11 fragments. The break edges are generally sharp and not eroded. The breaks occurred in the thinnest areas of the ceramic.</p>	 <p>Figure 146 shows 11 fragments of a ceramic object arranged in a circular pattern on a white surface. A ruler is visible at the bottom of the image for scale.</p>
<p><b>Lacunae:</b> The rim is approx. 60% complete. The volume of the whole object is unknown and four fragments do not attach to another.</p>	 <p>Figure 147 shows a close-up of a ceramic fragment with a yellowish-brown glaze. Two red circles highlight areas where the glaze is missing or has small holes, identified as lacunae.</p>
<p><b>Glaze lacunae:</b> There are a few lacunae in the glaze in the area surrounding the breaks, and because of poor glaze adhesion during fabrication. The glaze is generally in good condition.</p>	 <p>Figure 148 shows a close-up of a ceramic sherd with a yellowish-brown glaze. A thin, greyish deposit is visible on the surface of the sherd.</p>
<p><b>Crazing:</b> The glaze is lightly crazed over all the fragments. It has especially large cracks on the scalloped edges.</p>	<p><b>Separation:</b> Fissures are visible between pieces that were assembled, such as the handle and some decorative elements. This most likely occurred during drying or firing.</p>

### Surface alterations

<p><b>Deposits:</b> There is a faint light gray to gray soiling on the inside and the sunken-in parts of the fragments. It is quite thin and has in places penetrated the crazing of the glaze. It is adherent to the surface and cohesive.</p>	 <p>Figure 148 shows a close-up of a ceramic sherd with a yellowish-brown glaze. A thin, greyish deposit is visible on the surface of the sherd.</p>
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## Documentation of the glaze



*Table 17: Photography under magnification of the glaze colors of object 7220*

## 11. Detailed testing results

### 11.1 Cleaning

Solvent	Tools	Results
Water	Cotton swab	The deposits are not very soluble. This method alone takes a lot of time and might make the deposits penetrate into the cracks.
	Brush	This method does not apply enough mechanical force to remove the deposits.
	Melamine sponge	Works faster than with the cotton swab, but it is difficult to reach certain areas. Wets the surface very lightly, so there is less observable water absorption by the surface. Leaves a tiny bit of residue which can be brushed off.
	PVA Sponge*	Great water retention, very soft on the surface, helps make the deposits somewhat softer but does not remove them effectively.
Water + ethanol (50:50)	Cotton swab	The deposits are not very soluble. This method alone takes a lot of time and might make deposits penetrate in the cracks. Ethanol allows for better spread on the surface, less capillary absorption and faster drying.
	Brush	This method does not apply enough mechanical force to remove the deposits.
-	Scalpel	This method works well to remove deposits, although some residues are observed. There is a risk of scratching the glazed surface if not done carefully.

**Table 18:** Comments on the cleaning tests



## 11.2 Gap-filling

### Silicones and dental wax

	Putty silicone	Liquid silicone	Dental wax
Commercial name	AWASIL NOVO 50 AWASIL NOVO 50L	WAGNERSIL 32N	Cera reus modeling wax sheets
Technical data	Poly-additive silicone, 1:1 ratio Hardness: 50 Shore Pink color	Poly-additive silicone, 1:1 ratio Hardness: 32 Shore Blue color	Microcrystalline and paraffin wax Resistant to hot climates Pink color
Price	25,50 Euros/kg	30 Euros/kg	27,8 Euros/kg
Working time	1 – 4 mins (50) 10 mins (50L) Curing in 20 min to 1 hour	5 mins Curing in 2 hours	No curing time
Ease of use and versatility	Faster application, as no mold box or walls must be created. Applicable for small areas without undercuts. More rigid than liquid silicone. Some local cure inhibition has been noted (poor mixing?).	Short working time. Easily poured without many bubbles. No cure inhibition has happened, but it must be considered before application.	Very fast application process. Heat with a hair drier or heat gun and press against the surface. Applicable for small simple shapes. Deformation and scratches of the mold can occur easily.
Precision	Less precise than liquid silicone, but precise enough for our use.	Extremely precise.	Not very precise, used for general shapes.
Re-usability of the mold	It can technically stay supple and reusable for several years. The material is not re-usable or recyclable.		The mold is not re-usable. The material is re-usable.
Compatibility with the materials / damage to the ceramic	Rips off some fragile glaze flakes (because of higher rigidity). It should not be used on fragile glazes. Oily residues	No damage to the glaze. Oily residue, removed (partially) by several surface cleanings with White Spirit 100/140.	No damage to the glaze. No noticeable residues.

**Table 19:** Comments on the tests of silicones and dental wax

## Plasters

	Modelling Plaster (Knauf)	Alabaster plaster
Workability	Working time: 15 minutes End of stiffening: 35 minutes +/- 5 Drying time: 24 hours	Initial stiffening: 15 minutes +/- 5 End of stiffening: 35 minutes +/- 5 Drying time: 24 hours
	Sift into the water according to the maker's indications (5-6 parts demineralized water to 10 parts plaster for modelling; 7 parts water for casting). Let it sit in the water for two minutes, then mix thoroughly with stainless steel tools. It can be applied thick, with a spatula, or thin by pouring or brushing on.	
Expansion	Unknown data Probably swells less than 0,5% vol <sup>210</sup> .	Swelling: ca. 22 mm/m (0,22% vol.)
Cohesion and hardness	Density : 3g/cm <sup>3</sup> (approx.. <sup>211</sup> )	Density : 2.3 – 3g/cm <sup>3</sup>
Color	White.	Cold grey color.
Photo		
Precision	Very precise, but some details are eliminated during the sanding process, as we want a smooth surface. Some bubbles (partly because of user error).	
Price	3,75 Euros/kg	4,64 Euros/kg
Technical data	Calcium sulfate hemihydrate (CaSO <sub>4</sub> x 1/2H <sub>2</sub> O), probably alpha-hemihydrate	Calcium sulfate alpha hemi-hydrate (CaSO <sub>4</sub> x 1/2H <sub>2</sub> O)

**Table 20:** Comments on the tests of a modelling plaster and alabaster plaster




<sup>210</sup> Common swelling for alpha-semihydrate plasters, according to De Chavagnac, 2006, p.82.

<sup>211</sup> The data sheet of this material can be found in **Appendix 12:** "Product data sheets": Document 7, p.156.

## Modelling and sculpting materials

	Plastiline®	Clay	Self-curing clay
Workability (heat, tools, solvents) Working time	<ul style="list-style-type: none"> <li>- Modelled without cracking or drying.</li> <li>- Heat makes it softer (hands or hair drier). Do not apply heat directly to the object.</li> <li>- Pressure is necessary to get a good imprint. Incompatible with very fragile objects.</li> <li>- Shape and smooth with a scalpel or a hydrocarbon solvent.</li> </ul>	<ul style="list-style-type: none"> <li>- A rough shape can be made with wet clay.</li> <li>- Smoothing can be done with water.</li> <li>- More plastic than self-curing clay, also more messy.</li> <li>- Dries in about a day and a half.</li> <li>- Can be sanded after drying.</li> </ul>	<ul style="list-style-type: none"> <li>- A rough shape can be made with the soft clay.</li> <li>- Smoothing can be done with water.</li> <li>- Is not very plastic, but holds its shape well.</li> <li>- Does not adhere well to itself (humid on humid or humid on dry).</li> <li>- Tends to crack.</li> <li>- Dries in a day, is fully dry in 2-3 days.</li> <li>- Can be sanded after drying.</li> </ul>
Drying and retraction	It never dries and does not change dimensionally.	Whilst it did not crack, the material retracted the most and lost all contact with the sherds.	The material cracked a little bit and retracted.
Hardness and deformation	It stays soft, which can be a problem when taken out of a mold and manipulated <sup>212</sup> .	It is hard once cured. Slightly crumbly and de-cohesive in parts.	It is hard once cured, similar to plaster.
Health and safety	Reworking with a hydrocarbon solvent is a health risk and should be done under a fume hood. It is not necessary to obtain good results.	Working the clay is no risk for the human body. While sanding, a mask could be worn to prevent the inhalation of small silicate particles.	Working the clay is no risk for the human body. While sanding, a mask could be worn to prevent the inhalation of small silicate particles.
Compatibility with molding material	Compatible with both types of RTV silicones, if you use a sulfur-free plasticine (i.e. Plastiline® brand).	Compatible with both types of RTV silicones.	Compatible with both types of RTV silicones.
Surface texture	The surface is exceptionally smooth and non-porous. It tends to get scratched easily.	The surface texture is similar to that of plaster.	After sanding, the surface texture is similar to that of plaster but is covered in micro-cracks in places.
Precision	<p>The imprints of break edges are very precise.</p> <p>Very small elements deform easily when manipulated.</p>	<p>The imprint of break edges and silicon molds is quite good.</p> <p>Because of retraction, the contact is lost and the model is unusable.</p>	<p>The imprint of break edges and silicon molds is quite good.</p> <p>Because of retraction, the contact is lost and the model is unusable.</p>

<sup>212</sup> In our case, a Plastiline® of 55 "normal" hardness was used. Its Shore hardness is 48-52, and softening point 52-56°C. Softer and harder products can be purchased.

Re-usability	It is infinitely re-usable.	Could be re-used theoretically.	Is not re-usable.
Photos			

**Table 21:** Test results and observations on modeling materials

Two tests were done, one using a silicone mold for imprinting, the second sculpting out of nothing. For the silicone imprinting, it was finally decided that using plaster directly was appropriate. Nevertheless, the testing process is illustrated below.



**Figure 149:** Placement of the sherd on the silicone imprint



**Figure 150:** After the isolation of the ceramic edges, application of the clay into the imprint



**Figure 151:** After partial drying, the clay fill is moved to a sand support, and the apertures are cut out

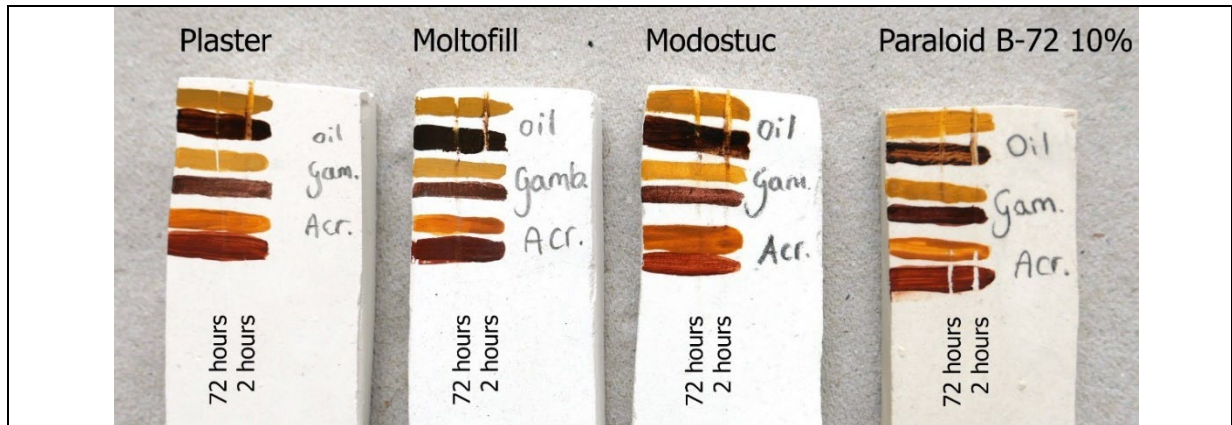
## 11.3 Retouching

### Surface finishing

	Plaster / Moltofil®	Modostuc®	Paraloid® B-72
Technical data	<p>Calcium sulfate hemihydrate</p> <p>Moltofil® contains a majority of calcium carbonate and some undetermined additives.</p>	<p>Inert (calcium carbonate and barium sulfate) 76-78% weight</p> <p>PVA 1,5 – 3% weight</p> <p>Poliglycol ester 0,5% weight</p> <p>Biocide (isothiazolones) 0,08-0,11% weight</p>	<p>Copolymer of ethyl methacrylate and methyl acrylate with a 70/30 ratio</p> <p>2% of butyl methacrylate <sup>213</sup></p>
Application method	<p>It was made with a higher proportion of water (7:10) and applied with a brush.</p> <p>After drying, it was sanded to a granulometry of 1000.</p>	<p>It was thinned out with water and mixed with a spatula, then applied with a brush.</p> <p>After drying, it was sanded to a granulometry of 1000.</p>	<p>After the application of Modostuc®, the fragment was put into a Paraloid® bath at 10% in ethyl acetate and left in until bubbles stop rising to the surface.</p> <p>It could also be applied with a brush.</p>
Surface hardness	Easily scratched	Harder than just plaster	Very hard surface
Color	White	White	Light brown
Porosity	Very porous and absorbent	Somewhat non-porous	Non-porous
Paint application	<p><b>Oil:</b> fast absorbance of the water, faster drying but difficult to apply and color change.</p> <p><b>Gamblin:</b> slightly streaky application.</p> <p><b>Acrylics:</b> fast absorbance of the water and extremely fast drying.</p>	<p><b>Oil:</b> relatively slow drying because of the low porosity.</p> <p><b>Gamblin:</b> the colors appear more vibrant. Good application</p> <p><b>Acrylics:</b> good application.</p> <p><i>Note: in reality, the surface is never fully homogenous because of sanding and some plaster peaks through.</i></p>	<p><b>Oil:</b> no absorption of the water, streaky appearance, very slow drying.</p> <p><b>Gamblin:</b> good application</p> <p><b>Acrylic:</b> streaky appearance</p>
Paint adhesion <sup>214</sup>	Good adhesion, but the surface is easily scratched.	Good adhesion.	The acrylic paints do not adhere well and were scratched off after 2 hours and 72 hours.







<sup>213</sup> Vincotte, et al., 2009, p.2.

<sup>214</sup> A scratch test was done by passing a wooden stick over the paints, while exercising light pressure.



**Table 22:** Test results and observations on surface finishing materials

### Paints and painting techniques

	Water mixable oil paint	Gamblin® colors	Golden® acrylics
Ease of use	Mixed with a large amount of water. Applied in very thin layers. Dries in up to 7 days.	Mixed in Dowanol	Mixed with a small amount of water
Solid color	 <p>Streaky, heterogeneous effect. Could be better by applying thinner, lighter layers, but would take too much time considering drying times.</p>	 <p>Without Paraloid</p> <p>Streaky, unsatisfying effect. The drying is too fast and the colors become too dark upon drying.</p>  <p>With Paraloid</p> <p>Applying Paraloid® to the surface makes the application more even.</p>	-
Pointillism – paintbrush	-	 <p>Slightly translucent, and tricky for darker colors, as the superposition of new layers dissolves the underlying layers, making it look hazy. This can be a good visual effect but is somewhat uncontrollable.</p>	 <p>They are opaque and don't mix once they are dry and thus appear more vibrant. This makes it somewhat more difficult to obtain a more "dirty" and "old" looking object, but is much more controllable.</p>
Pointillism – projection with a toothbrush	-	-	<p>The colors are more watered down and it creates a more "natural" effect, but it less controllable, difficult for hard-to-reach spots, risky for the object, and hardly precise.</p> 
Stability and aging	The pigments are lightfast but the oil binder's aging has not been studied. It most likely will darken over time.	The aging of these colors has been studied in the context of conservation and has been proven to be satisfying.	The aging of these paints has been studied in the context of conservation and has been proven to be satisfying.

**Table 23:** Test results and observations on retouching media and techniques

## 12. Product data sheets

### QUANTOFIX® Nitrate 100

en

**Description:**

QUANTOFIX® Nitrate 100 are test strips for the semi-quantitative determination of nitrate ions ( $\text{NO}_3^-$ ) in aqueous solutions or samples. False positive color reactions of the nitrate test field in concomitant presence of nitrite ( $\text{NO}_2^-$ ) are indicated by an additional nitrite test field. QUANTOFIX® Nitrate 100 test strips are also suitable for reflectometric evaluation using the QUANTOFIX® Relax (REF 913 46).

**Pack content:**

1 aluminum container with 100 test strips

**Measuring range:**

Visually:  
 5–100 mg/L nitrate  $\text{NO}_3^-$   
 0.5–50 mg/L nitrite  $\text{NO}_2^-$

Reflectometrically:  
 3–100 mg/L nitrate  $\text{NO}_3^-$   
 0.5–50 mg/L nitrite  $\text{NO}_2^-$

**Color gradation:**

0 · 5 · 10 · 25 · 50 · 75 · 100 mg/L nitrate  $\text{NO}_3^-$   
 0 · 0.5 · 2 · 5 · 10 · 25 · 50 mg/L nitrite  $\text{NO}_2^-$

**General indications:**

Remove only as many test strips as are required. Close the container immediately after removing a strip. Do not touch the test fields.

**Instructions for use:**

1. Insert the test strip with both fields into the test solution for 1 s.
2. Shake off excess liquid.
3. Wait 60 s.

4. Compare the test fields immediately to the color scale. Read the values which match the color of the test fields most closely (reading accuracy:  $\pm \frac{1}{2}$  colored field of the scale). If nitrate ions are present, the outer test field (at the end of the strip) will turn red-violet. In case of a color change of the nitrite warning field (at the holding end) please read the information on "Interferences".

The reaction color of the test fields may change after the value has been taken. It is therefore crucial to evaluate the coloration within the prescribed time scale in order to achieve a correct result.

**Interferences:**

In case of a positive color change of the nitrite test field, the result of the nitrate determination is invalid. To eliminate the nitrite interference, add 1 spoonful of amidosulfuric acid (REF 918 973) to 10 ml. of the sample. Subsequently repeat the test with this solution.

Strongly acidic solutions (pH < 1) must be buffered with sodium acetate, and alkaline solutions (pH > 12) with citric acid to a pH of 3–5.

The following ions do not interfere yet with the determination when the concentrations below are not exceeded (tested with 0 and 25 mg/L, respectively, of nitrate solutions):

- 1000 mg/L:  $\text{Al}^{3+}$ ,  $\text{As}^{3+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Na}^+$ ,  $\text{Ni}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Cl}^-$ ,  $\text{CN}^-$ ,  $\text{SO}_4^{2-}$
- 500 mg/L:  $\text{Fe}^{2+}$ ,  $\text{S}_2\text{O}_3^{2-}$
- 250 mg/L:  $\text{Fe}^{3+}$ ,  $\text{S}_2\text{O}_8^{2-}$
- 100 mg/L:  $[\text{Fe}(\text{CN})_6]^{3-}$ ,  $[\text{Fe}(\text{CN})_6]^{4-}$ ,  $\text{Hg}^{2+}$ ,  $\text{SCN}^-$
- 50 mg/L:  $\text{Ag}^+$ ,  $\text{Hg}^+$
- 25 mg/L:  $\text{S}^{2-}$
- 0.25 mg/L:  $\text{NO}_2^-$  (see above)

**Note:**

The test strip container stopper contains a non-toxic drying agent. If swallowed, drink plenty of water.

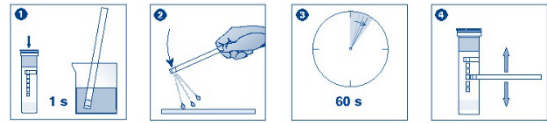
**Disposal:**

Used test strips can be placed in the normal household waste.

**Storage:**

Avoid exposing the strips to sunlight and moisture. Keep container cool and dry (storage temperature not above +30 °C).

If correctly stored, the test strips may be used until the use-by-date printed on the packaging.



<b>REF</b>	Artikelnummer / Item number / Référence produit / Referencia / Artikelnummer / Numero di catalogo / Numer artykułu	<b>LOT</b>	Chargencode / Batch identification / Numéro de lot / Código de lote / Producentnummer / Codice del lotto / Numer partii
	Achtung! / Warning! / Attention! / Atención! / Let op! / Attenzione! / Uwaga!		Verwendbar bis / Use by / À utiliser avant / Fecha de caducidad / Te gebruiken tot / Utilizzare entro (anno / mese) / Przydatność do użycia
	Temperaturbegrenzung / Permitted storage temperature range / Limites de température / Limites de temperatura / Temperaturbegrenzung / Limite de temperatura / Ograniczenie temperatury		Trocken aufbewahren / Store in a dry place / Conserver au sec / Mantener seco / Op een droge plaats bewaren / Mantenerse asciutto / Przechowywać w suchym miejscu
	Gebrauchsanweisung beachten / Please read instructions for use / Respecter les instructions d'utilisation / Obsérvese las instrucciones de uso / Lees de bijsluiter / Consultare le istruzioni per l'uso / Przestrzegać instrukcję użycia		Packung geschlossen halten / Keep container closed / Refermer la boîte / Mantenga el envase cerrado / Verpakking gesloten houden / Conservare la confezione chiusa / Przechowywać pojemnik szczelnie zamknięty
	Ausreichend für <n> Prüfungen / Contains sufficient for <n> tests / Contenu suffisant pour <n> tests / Contenido suficiente para <n> tests / Voldoende voor <n> tests / Contenuto sufficiente per <n> test / Wystarczająco dla kontroli <n>		

MACHEREY-NAGEL GmbH & Co. KG · Neumann-Neander-Str. 6–8 · 52855 Düren · Germany  
 Tel.: +49 24 21 969 0 · Fax: +49 24 21 969 199 · info@mn-net.com · www.mn-net.com

Rev 2014-10 A045512/913 51 / 1042

**Document 1: Instruction manual for the soluble salt (nitrate) test strips.**  
 Source: Carl Roth [online].

<b>Safety Data Sheet</b> according to Regulation (EC) No. 1907/2006  <b>AWASIL</b> <b>Putty silicone</b>	Wagner Dental Rheinstr. 7 D-41836 Hückelhoven  Update: 25.07.2020 Page: 1 of 8
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#### Section 1: Identification of the substance/mixture and of the company/undertaking

- 1.1 Product identifier:**  
**Commercial product name:** AWASIL NOVO 20 (Base + Catalyst)  
 AWASIL NOVO 30 (Base + Catalyst)  
 AWASIL NOVO 40 (Base + Catalyst)  
 AWASIL NOVO 50 (Base + Catalyst)  
 AWASIL NOVO 70 (Base + Catalyst)  
 AWASIL NOVO 85 (Base + Catalyst)  
 AWASIL NOVO 90 (Base + Catalyst)  
 AWASIL NOVO 95 (Base + Catalyst)
- 1.2 Relevant identified uses of the substance or mixture and uses advised against:**  
**Use of substance/preparation:** Commercial, kneadable silicone for various applications
- 1.3 Manufacturer/distributor:** Wagner Dental GmbH & Co. KG  
 Rheinstr. 7  
 D-41836 Hückelhoven  
 E-Mail: info@wagnerdent.de  
 Internet: www.wagnerdent.de
- 1.4 Emergency telephone number:** Departement of work safety, Mr. Pollock  
 Phone: +49 2433 970 410  
 Fax: +49 2433 970 412

#### Section 2: Hazards identification

- 2.1 Classification of the substance or mixture:**  
**Classification according to Directive 67/548/EEC or 1999/45/EC:**  
 This mixture is not classified as hazardous according to Directive 1999/45/EC.  
**Classification according to Regulation (EC) No. 1272/2008 [CLP]:**  
 This mixture is not classified as hazardous according to Regulation (EC) No. 1272/2008.
- 2.2 Label elements:**  
**Special labelling of certain mixtures:**  
 EUH210 Safety data sheet available on request.
- 2.3 Other hazards:**  
 No information available.

#### Section 3: Composition/information on ingredients

- 3.2 Mixtures:**  
**Chemical characteristics:**  
 Contains polydimethylsiloxane with functional groups + fillers and pigment  
 Catalyst: additionally platinum complex compound.

<b>Safety Data Sheet</b> according to Regulation (EC) No. 1907/2006  <b>AWASIL</b> <b>Putty silicone</b>	Wagner Dental Rheinstr. 7 D-41836 Hückelhoven  Update: 25.07.2020 Page: 2 of 8
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#### Hazardous components:

EG No.	Chemical name	Quantity
CAS No.	Classification according to Directive 67/548/EEC	
Index No.	Classification according to Regulation (EC) No. 1272/2008 [CLP]	
REACH No.		
238-455-4	Cristobalite	30 - <70 %
14464-46-1	Xn - Harmful R48/20	
	STOT RE 1; H372	
232-455-8	Paraffinum perliquidum P 615	1 - <10 %
8042-47-5		
	Asp. Tox. 1; H304	
01-2119487078-27		

Full text of R-, H- and EUH-phrases: see section 16.

#### Section 4: First aid measures

- 4.1 Description of first aid measures:**  
**After inhalation:** Provide fresh air. Medical treatment necessary  
**After contact with skin:** Wash with plenty of water. Immediately remove any contaminated clothing, shoes or stockings. Medical treatment necessary.  
**After contact with eyes:** Rinse immediately carefully and thoroughly with eye-bath or water. Consult an ophthalmologist.  
**After ingestion:** Rinse mouth immediately and drink plenty of water. Let water be drunk in little sips (dilution effect). Do not induce vomiting. If you feel unwell, seek medical advice.
- 4.2 Most important symptoms and effects, both acute and delayed:**  
 No information available.
- 4.3 Indication of any immediate medical attention and special treatment needed:**  
 Treat symptomatically.

#### Section 5: Firefighting measures

- 5.1 Extinguishing media:**  
**Suitable extinguishing media:**  
 Co-ordinate fire-fighting measures to the fire surroundings.
- 5.2 Special hazards arising from the substance or mixture:**  
 Non-flammable. Vapours can form explosive mixtures with air.
- 5.3 Advice for firefighters:**  
 In case of fire: Wear self-contained breathing apparatus.  
**Additional information:**  
 Use water spray jet to protect personnel and to cool endangered containers. Suppress gases/vapours/mists with water spray jet. Collect contaminated fire extinguishing water separately. Do not allow entering drains or surface water.

**Document 2:** First pages of the AWASIL Putty Silicone Safety Data Sheet. The full SDS can be found on [www.zahntechnikshop.de/en/c/safety-data-sheets-instructions-for-use-operating](http://www.zahntechnikshop.de/en/c/safety-data-sheets-instructions-for-use-operating)

**EC safety data sheet**  
according to Regulation (EC) No. 1907/2006**WAGNERSIL**  
duplicating siliconeWagner Dental GmbH & Co. KG,  
Rheinstr. 7,  
D-41836 HückelhovenUpdate: 27.05.2021  
Page: 1 of 8**Section 1: Identification of the substance/mixture and of the company/undertaking**

- 1.1 Product identifier:**  
**Commercial product name:** **WAGNERSIL**  
9N, 17N, 20NF, 21NO, 22NF, 22N, 22S, 25NF,  
25L, 26LE, 28LE, 32N, 35LE  
**Component B**
- 1.2 Relevant identified uses of the substance or mixture and uses advised against:**  
**Use of substance/preparation:** Silicone for the manufacturing of duplicating models
- 1.3 Manufacturer/distributor:** WAGNER DENTAL GmbH & Co. KG  
Rheinstr. 7  
D-41836 Hückelhoven  
E-Mail: [info@wagnerdent.de](mailto:info@wagnerdent.de)  
Internet: [www.wagnerdent.de](http://www.wagnerdent.de)
- 1.4 Emergency telephone number:** Department of work safety, B. Pollock  
Phone: +49 2433 970410  
Fax: +49 2433 970412

**Section 2: Hazards identification**

- 2.1 Classification of the substance or mixture:**  
Not a hazardous substance or mixture.
- 2.2 Label elements:** No labeling according to GHS required.
- 2.3 Other hazards:** Product can release hydrogen. Danger of oxyhydrogen gas formation with water, alcohols, acids, metallic salts, amines and alkalis.

**Section 3: Composition/information on ingredients**

- 3.1. Substances:** not applicable
- 3.2. Mixtures:**  
**Chemical characteristics:** Polydimethylsiloxane with functional groups and auxiliary.  
**Hazardous components:**
- | Type | CAS No.          | EG No.    | Substance    | Content % | Classification*                                    | Remark |
|------|------------------|-----------|--------------|-----------|--|--------|
|      | <b>REACH No.</b> |           |              |           |  |        |
| INHA | 14464-46-1       | 238-455-4 | Cristobalite | 10 - 15   | Xn;<br>R48/20<br><br>STOT RE 1 inhalative;<br>H372 | (1)    |

Type: INHA: Ingredient  
(1) = Health or environmentally hazardous substance  
\* The data of the classification are explained in section 16.  
Cristobalite: This ingredient does not lead to classification, due to the physical nature of the material, the risk of inhalation is not given.

**EC safety data sheet**  
according to Regulation (EC) No. 1907/2006**WAGNERSIL**  
duplicating siliconeWagner Dental GmbH & Co. KG,  
Rheinstr. 7,  
D-41836 HückelhovenUpdate: 27.05.2021  
Page: 2 of 8**Section 4: First aid measures**

- 4.1 Description of first aid measures:**
- General information:** In case of accident or if you feel unwell seek medical advice (show label or SDS where possible).
- After contact with the eyes:** Remove contact lenses, if worn. Rinse immediately with plenty of water. Seek medical advice in case of continuous irritation.
- After contact with the skin:** Wipe off excess material with cloth or paper. Wash with plenty of water or water and soap. In the event of a visible skin change or other complaints, seek medical advice (show label or SDS where possible).
- After inhalation:** Material cannot be inhaled under normal conditions.
- After swallowing:** Give several small portions of water to drink. Do not induce vomiting.
- 4.2 Most important symptoms and effects, both acute and delayed:**  
Any relevant information can be found in other parts of this section.
- 4.3 Indication of any immediate medical attention and special treatment needed:**  
Further toxicology information in section 11 must be observed.

**Section 5: Firefighting measures**

- 5.1 Extinguishing media:**  
**Suitable extinguishing media:**  
Fires can be controlled with water spray, foam or carbon dioxide. Larger fires are best fought with alcohol-resistant aqueous film forming foam (AFFF-AR).  
**Extinguishing media which must not be used for safety reasons:**  
Water jet, extinguishing powder, halones.
- 5.2 Special hazards arising from the substance or mixture:**  
Risk of hazardous gasses or fumes in the event of fire. Exposure to combustion products may be a health hazard! Hazardous combustion products: carbon oxides, silicon oxides, incompletely burnt hydrocarbons, toxic and very toxic fumes.  
With the use of water-based extinguishing agents care is required because hydrogen can be released, which accumulates after extinguishing the fire in poorly ventilated or confined areas and may re-fire or cause an explosion. Foam carpets may also include hydrogen or flammable vapors, which can lead to surface bursts. Remove sources of ignition during cleaning and absorbing.
- 5.3 Advice for firefighters:**  
**Special protective equipment for fire fighting:**  
Use respiratory protection independent of recirculated air. Keep unprotected persons away.  
**General information:**  
Fires involving SiH polysiloxane materials can be difficult to extinguish under certain circumstances.

**Section 6: Accidental release measures**

- 6.1 Personal precautions, protective equipment and emergency procedures:**  
Secure the area. Wear personal protection equipment (see section 8).  
If material is released indicate risk of slipping.

**Document 3:** First pages of the WAGNERSIL liquid silicone Safety Data Sheet. The full SDS can be found on [www.zahntechnikshop.de/en/c/safety-data-sheets-instructions-for-use-operating](http://www.zahntechnikshop.de/en/c/safety-data-sheets-instructions-for-use-operating)

## Technical Data Sheet



### Rhenodiv® BO-501-2

Release Agents

#### Function

Compound release agent in powder form for batch-off operations

#### Product description

Composition:	combination of inorganic fillers, synthetic fillers and surfactants
Appearance:	grayish powder
Bulk density [g/cm³@20°C]:	ca. 0.62
Ash content [%]:	approx. 63
pH, 20 °C (5 %):	approx. 9.5
Solubility:	dispersible in water
Physiological properties:	see safety data sheet

#### Use

Mode of action: Rhenodiv BO-501-2 is a batch-off release agent for rubber processing (slab dip process). It is a powder (100 % of active ingredient). Rhenodiv BO-501-2 exhibits the following characteristics:

- easy to disperse in water
- compatible with water of different hardness
- excellent wetting of rubber sheets
- excellent release effect
- fast drying
- low working concentration, low consumption
- low dust formation
- low build-up and contamination of the equipment
- minimal sedimentation
- minimal foam formation

Rhenodiv BO-501-2 forms a thin, flexible film on the surface of the rubber sheets. The special inorganic fillers of optimized particle size distribution act as microscopic spacers between the sheets, providing excellent release properties. Still, friction between the sheets is sufficient to prevent sheets from slipping during storage, while allowing smooth, continuous feeding of extruders. Economic and efficient working is provided.

#### Processing:

For best performance good dispersion of the powder in water is crucial. It is recommended to use a separate dispersion tank equipped with a paddle stirrer. The powder is added to the water that ideally has a temperature of ca. 50 °C. The slurry should be stirred for at least 30 min before use. Dispersion time in cold water should be extended as long as necessary. Optimal results are achieved by preparing a slurry of 10-12 % concentration in a first stage which will then be diluted to the actual work concentration. During the batch-off process only slight agitation is needed to prevent sedimentation. Usually the motion of the bath during to the dipping process is sufficient.

#### Dosage:

Depending on the type of rubber compound, a working concentration of 1.5-3.0 % is recommended.

#### Applications:

Standard slab dip equipment

#### Packing

20 kg paper bags on 800 kg plastic pallets

#### Storage stability

In original closed containers under cool and dry conditions 24 months min. from day of production

#### Handling

Please consult material safety data sheet (MSDS) for additional handling information on Rhenodiv BO-501-2.

The indicated data are not to be considered as specification.

Our technical advice - whether verbal, in writing or by way of trials - is given in good faith but without warranty, and this also applies where proprietary rights of third parties are involved. It does not release you from the obligation to test the products supplied by us as to their suitability for the intended processes and uses. The application, use and processing of the products are beyond our control and, therefore, entirely your own responsibility. Should, in spite of this, liability be established for any damage, it will be limited to the value of the goods delivered by us and used by you. We will, of course, provide products of consistent quality within the scope of our General Conditions of Sale and Delivery.



LANXESS Deutschland GmbH  
Business Unit Rhein Chemie  
Kennedyplatz 1  
D-50569 Cologne, Germany  
<http://rch.lanxess.com>



CERAS DENTALES  
CERAS ESPECIALES

Plaça del Castell, 5 – baixos  
Tel. 977 341 240 – Fax: 977 345 021  
43201 Reus (Spain)

## **SAFETY DATA SHEET**

According to the Comisión Directive 91/155/CE and 93/112/CE

### 1.- CHEMICAL PRODUCT AND COMPANY IDENTIFICATION.

-PRODUCT NAME : **MODELLING WAXES CODE 21000000 AT 22999999**

- MANUFACTURER: CERA REUS, S.A.  
PL. CASTELL, 5  
43201 – REUS  
TEL. 34 977 341 240  
FAX. 34 977 345 021

- EMERGENCY TELEPHONE NUMBER: 34 977 341 240

### 2.- COMPOSITION/INFORMATION ON INGREDIENTS.

- MICROCRYSTALLINE WAXES + PARAFFIN WAXES + RESINS

### 3.- HAZARDS IDENTIFICATION.

- THIS PRODUCT IS NOT EXPECTED TO PRESENT ANY UNUSUAL HAZARDS IN PROPER USE.  
- THIS PRODUCT IS OFTEN TRANSPORTED AND HANDLED HOT CARE SHOULD BE TAKEN TO PREVENT THERMAL BURNS.

### 4.- FIRST AID MEASURES.

- INHALATION: NO EFFECTS KNOWN UNDER NORMAL CONDITIONS OF USE.  
- INGESTION: NO EFFECTS KNOWN UNDER NORMAL CONDITIONS OF USE.  
- EYES: WASH WITH WATER. IF IRRITATION PERSISTS, CONSULT PHYSICIAN.  
- SKIN: IF BURNED BY CONTACT WITH HOT MATERIAL, COOL BURNED SKIN AREA AS QUICKLY AS POSSIBLE BY IMMERSING IN COLD WATER, OR APPLYING COLD WATER. CALL A PHYSICIAN.

### 5.- FIRE FIGHTING MEASURES.

- EXTINGUISHING MEDIA: CARBON DIOXIDE, DRY CHEMICAL OR FINE WATER SPRAY AND SAND.  
- SPECIAL FIREFIGHTING PRECAUTIONS: AVOID WATER STREAM ON MOLTEN BURNING MATERIAL AS IT MAY SCATTER AND SPREAD THE FIRE. AN INCORRECT APPLICATION OF THE WATER CAN MAKE THAT THE PRODUCT OVERFLOWS AND EXTEND.



## 58343 Alabaster Plaster

Chemical composition: Semi-hydrated calcium sulfate  $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$

### Product Information:

Fine, white model gypsum.

### Product Properties:

- High grinding fineness
- High degree of whiteness
- Does not contain any additives, is not toxic nor caustic, is environmentally safe
- Can be painted over after hardening and priming

### Application:

Suitable for creative works such as moulding, structuring, forming and mould casting.

### Processing:

- Add Alabaster Plaster slowly to mixing water
- After a soaking period of about 2 minutes, stir strongly and intensively
- Use only stainless tools
- Clean tools with water immediately after use
- The processing temperature should not be below  $+5^\circ\text{C}$
- Cure sufficiently before priming

### Technical Data

Degree of whiteness:	$\geq 80$
Sieve residuc	
through 0.2 mm	$\leq 0.1$
through 0.09 mm	$2.0 \pm 1$
through 0.032 mm	$25.0 \pm 3$
Degree of hydratation:	$\geq 82 \%$
Initial stiffening:	$15 \pm 5 \text{ min}$
End of stiffening:	$36 \pm 8 \text{ min}$

### Structural Values:

Bulk density:	$850 \pm 30 \text{ kg/m}^3$
Flexural strength:	$\geq 3,5 \text{ N/mm}^2$
Compressive strength:	$\geq 8 \text{ N/mm}^2$
Brinell hardness:	$\geq 12 \text{ N/mm}^2$
Swelling:	ca. 22 mm/m

### Mixing Ratio:

Modeling: use about 5 – 6 liters of water for 10 kg Alabaster Plaster.

Mould casting: use about 7 liters of water for 10 kg Alabaster Plaster.

## Modelliergips



### Modelliergips

Besonders reiner Gips zum Formen und Modellieren.

#### Einsatzbereich

Modelliergips eignet sich besonders gut zum Gießen von Figuren und Formen, für verschiedene Bastelarbeiten sowie zum Renovieren von Stuckarbeiten.  
Geeignet für: innen.

#### Produktdetails

- Guter Weißgrad
- Gips von besonderer Reinheit
- Naturgips
- Im Modellbau perfektes Anschmiegen an die Form
- Hohe Oberflächenqualität
- IBO geprüft



#### Prüfbescheide & Gutachten

Prüfbescheide



IBO

Brandverhalten nach EN 13501-1: A1 (Nichtbrennbar) Produkttyp: EN 13279-1: Gipsbinder und Gips-Trockenmörtel, A2: Gipsbinder zur Direktverwendung auf der Baustelle

#### Verarbeitung

Untergrundvorbereitung

Der Untergrund muss tragfähig, sauber, trocken, staub- und fettfrei sein. Untergrund eventuell voranstrichen.

Anmischen

Modelliergips nur in klares Wasser einstreuen, ca. 2 Minuten sumpfen lassen und klumpenfrei anrühren.

Verarbeitung

Nach der Verarbeitung erfolgt das Glätten mit einem Pinsel oder feuchten Schwamm. Das Schleifen ist erst nach vollständiger Durchhärtung möglich, danach kann überklebt bzw. mit handelsüblichen Farben oder Lacken überstrichen werden.

#### Ergänzende Hinweise

Arbeitsgeräte sofort nach Gebrauch mit Wasser reinigen.

#### Lagerung

Lagerfähigkeit: ca. 12 Monate  
Lagerart: auf ebenem Untergrund im verschlossenen Gebinde  
Lagerbedingungen: kühl, trocken

#### Entsorgung

Entsorgung gemäß den behördlichen Vorschriften.

#### Anwendungstechnische Daten

- Verarbeitungstemperatur > 5 °C
- Verarbeitungszeit ca. 15 Min.
- Trocknungszeit ca. 24 Std.

#### Materialtechnische Daten

- Chemische Charakterisierung Calciumsulfat-Halbhydrat
- Form pulverig
- Farbe weiß, beige, gelb, grau
- Geruch geruchlos
- Beschreibung Thermische Zersetzung von Gips in CaSO<sub>4</sub> und H<sub>2</sub>O
- Zustandsänderung Thermische Zersetzung von Gips in CaO und SO<sub>3</sub>
- Siedepunkt in °C Nicht anwendbar.
- Schmelzpunkt in °C Nicht anwendbar.
- Flammpunkt in °C Nicht anwendbar.
- Zündtemperatur in °C Nicht anwendbar.

#### Sicherheitstechnische Daten

Erste-Hilfe-Maßnahmen

Frischluftzufuhr, bei Beschwerden Arzt aufsuchen.

Nachwaschen mit Wasser.

Bei Berührung mit den Augen, bei geöffnetem Lidspalt mehrere Minuten unter fließendem Wasser abspülen und Arzt konsultieren.

Mund ausspülen und Wasser trinken. Bei anhaltenden Beschwerden Arzt aufsuchen.

Keine

Weitere sicherheitstechnische Details entnehmen Sie bitte dem Sicherheitsdatenblatt.

#### Lieferform/Verbrauch

33012	4006379024001	1 kg
33013	4006379023974	2,5 kg
5791	4006379023981	5 kg



Silitech AG  
Worbstrasse 173  
3073 Gümliigen  
Telefon 031 398 50 70  
Fax 031 398 50 80  
[info@silitech.ch](mailto:info@silitech.ch)  
[www.silitech.ch](http://www.silitech.ch)

## Plastiline

### Produktbeschreibung

Ein Profi-Produkt für zahlreiche Anwendungsgebiete. Ob für die Erstellung von Plastiken, zur Restaurierung, Realisierung von Abgüssen, Messungen von Reliefs oder zur Erstellung von Reproduktionen (Genauigkeit 1/10 mm) und Kopien, mit diesem Produkt ist all dies möglich. Diese feinkörnige, öl-/wachshaltige Modelliermasse trocknet niemals aus, das Modell kann immer wieder verändert werden. Plastiline® kann mit den Händen, einer Heißluftpistole oder einem Fön weich gemacht werden, beim Abkühlen im Kühlschrank härtet sie wieder aus. Sie behält ihre Festigkeit bei und hinterlässt keine Rückstände beim Trocknen. Die Abgussmasse verformt sich nach der Erstellung des Modells nicht, da sie eine hervorragende Stabilität besitzt. Mit Acrylfarbe bemalbar

### Physikalische Eigenschaften

Artikelnummer	Härtegrade	Erweichung	Typical
47-602.K001 47-602.K005	40 = sehr weich,	39-41°C	
47-603.K001 47-603.K001	50 = weich,	48-52 °C	
47-604.K001 47-604.K001	55 = standard	52-56 °C	
47-605.K001 47-605.K001	60 = hart,	56-58°C	
47-606.K001 47-606.K005	70 = sehr hart,	58-60 °C	

Silitech AG; Worbstrasse 173 CH 3073 Gümliigen +41 31 398 50 70 info @silitech.ch

*Document 8: Technical Data Sheet of Plastiline®*

**Sicherheitsdatenblatt**

gemäß Verordnung (EG) Nr. 1907/2006

<b>Softton</b>		
Datum: 14.03.2018	Überarbeitet am:	Seite 1 von 7

**ABSCHNITT 1: Bezeichnung des Stoffs beziehungsweise des Gemischs und des Unternehmens**

**1.1. Produktidentifikator**

Softton

**Weitere Handelsnamen / Artikelnummern**

6 8075 101, 6 8075 137, 6 8075 201, 6 8075 237, 6 8075 301, 6 8075 337

**1.2. Relevante identifizierte Verwendungen des Stoffs oder Gemischs und Verwendungen, von denen abgeraten wird**

**Verwendung des Stoffs/des Gemischs**

Modellierton

**Verwendungen, von denen abgeraten wird**

Es liegen keine Informationen vor.

**1.3. Einzelheiten zum Lieferanten, der das Sicherheitsdatenblatt bereitstellt**

Firmenname:	GLOREX GmbH	GLOREX AG
Straße:	Großmattstraße 17	Uferstrasse 12
Ort:	D-79618 Rheinfelden	CH-4414 Füllinsdorf
Telefon:	+49 7623 72330	+41 61906 8070
E-Mail:	info@glorex.com	
Internet:	www.glorex.com	

**1.4. Notrufnummer:** +49 7623 72330 (Mo - Fr: 8 - 16 h)

**ABSCHNITT 2: Mögliche Gefahren**

**2.1. Einstufung des Stoffs oder Gemischs**

**Verordnung (EG) Nr. 1272/2008**

Das Gemisch ist nicht als gefährlich eingestuft im Sinne der Verordnung (EG) Nr. 1272/2008.

**2.2. Kennzeichnungselemente:** keine

**2.3. Sonstige Gefahren**

Es liegen keine Informationen vor.

**ABSCHNITT 3: Zusammensetzung/Angaben zu Bestandteilen**

**3.2. Gemische**

**Chemische Charakterisierung**

Wasser, Tonerde, Quarz

**Gefährliche Inhaltsstoffe**

CAS-Nr.	Bezeichnung	Anteil
	EG-Nr. Index-Nr. REACH-Nr.	
	Einstufung gemäß Verordnung (EG) Nr. 1272/2008 [CLP]	
14808-60-7	Quarz	< 20 %
	238-878-4	
	Stoff mit Arbeitsplatzgrenzwert	

Wortlaut der H- und EUH-Sätze: siehe Abschnitt 16.

**Weitere Angaben**

Der Anteil des lungengängigen kristallinen Siliziums im Quarz liegt unter 1%.

**ABSCHNITT 4: Erste-Hilfe-Maßnahmen**

**4.1. Beschreibung der Erste-Hilfe-Maßnahmen**



**Sicherheitsdatenblatt**  
Nach Verordnung (EG) Nr. 1907/2006

**8300,8301,8302 E**  
Artikelnummer

Erstellt am: 25.11.2010

Überarbeitet am: 26.04.2017

Gedruckt am: 17.04.2018, nuernber

Seite 1 von 7

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**ABSCHNITT 1: Bezeichnung des Stoffs bzw. des Gemischs und des Unternehmens**

**1.1. Produktidentifikator**

Keramiplast, verschiedene Farben

**1.2. Relevante identifizierte Verwendungen des Stoffs oder Gemischs und Verwendungen, von denen abgeraten wird**

**Relevante identifizierte Verwendungen:**

Modelliermasse(n) für Hobby- und Bastelarbeiten

**Verwendungen, von denen abgeraten wird:**

keine bekannt

**1.3. Einzelheiten zum Lieferanten, der das Sicherheitsdatenblatt bereitstellt**

STAEDTLER MARS GmbH & Co. KG  
Moosäckerstrasse 3  
90427 Nürnberg  
DE - Deutschland

Telefon: +49-(0)911-9365-0

e-Mail Adresse: info@staedtlr.de

**Für das Sicherheitsdatenblatt zuständig:**

Andreas Schäfer, Produktsicherheit

e-Mail Adresse: sdb@staedtlr.com

**1.4. Notrufnummer: +49-(0)911-9365-731** Nur während der Bürozeiten: Mo – Fr, 8:30 – 17:00

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**ABSCHNITT 2: Mögliche Gefahren**

**2.1. Einstufung des Stoffs oder Gemischs**

Dieses Produkt ist nicht gefährlich im Sinne der Verordnung (EG) Nr. 1272/2008

**Einstufung gemäß Verordnung (EG) Nr. 1272/2008:**

G0B100 Nicht kennzeichnungspflichtig

**2.2. Kennzeichnungselemente**

**Kennzeichnungselemente nach Verordnung (EG) Nr. 1272/2008 (CLP)**

Dieses Produkt ist nicht gefährlich im Sinne der Verordnung (EG) Nr. 1272/2008

**Einstufung gemäß Verordnung (EG) Nr. 1272/2008:**

G0B100 Nicht kennzeichnungspflichtig

**Signalwörter:**

entfällt

**Gefahrenbestimmende Komponente(n) zur Etikettierung:**

Nicht anwendbar

**Gefahrenmerkmale:**

—

**H-Sätze:**

H0 keine H-Sätze

**P-Sätze:**

**Document 10:** First page of the SDS of the self-hardening clay. The full document can be found on  
[https://www.gerstaecker.at/GERSTAECKER-Keramiplast-Modelliermasse.html?gclid=Cj0KCQjwuLShBhC\\_ARIsAFod4fJxIBxuql-rpySQGKBWORQE6mOUOafVj\\_ryEz8uHglkBPnTE9rv0YaAm11EALw\\_wcB](https://www.gerstaecker.at/GERSTAECKER-Keramiplast-Modelliermasse.html?gclid=Cj0KCQjwuLShBhC_ARIsAFod4fJxIBxuql-rpySQGKBWORQE6mOUOafVj_ryEz8uHglkBPnTE9rv0YaAm11EALw_wcB)



## Safety Data Sheet



Product of Italy

Plasveroi, International

Date: August 2009

1) Identification of the substance/preparations and company

1.1 Identification of the preparation

Description special paste

Commercial product name: Modostuc

Nomenclature Chemical Abstract : non-existent N. CAS: nonexistent N.CEE: non-existent

Empirical formulas: non-existent

1.2 Identification of the company

Corporate name: Plasveroi International

Address 27010 Giovenzano (PV), Via Camussone,

38 Phone Number 0382926895

Emergency Toxicological Information Service of

Niguarda, Phone number 02-66101029

2) Composition/Information of ingredients

Vinyversatic resin PVA 1.5-3% weight dryness

Fatty acid poliglycol ester 0.5% in weights

Biocide with isothiazolones 0.08-0.11 % un weight

Inert 76-78% in weight

3) Hazard Identification

The chemical – physical property of this product does not represent any risks for the health of man

4) First Aid Measures

Eye Contact: Wash with plenty of water for several minutes and seek medical advise

Ingestion:

Induce Vomiting

5) Fire Fighting Measures

There are no measures to adopt because the product is not flammable

6) Accidental Release Measures

Personal protections: nothing else

Environmental Protections: Do not allow spill to enter sewers, drains and water conduits

Cleaning Pick up: Pick up the product with fit means

7) Handling and storage

7.1 Handling

It is not necessary to take particular precaution

7.2 Storage

Store the product in a cool well ventilated place

**Document 11: SDS of Modostuc®**

Source : Talas Online

**SECTION 3 - COMPOSITION/INFORMATION ON INGREDIENTS**

CODE		Max %	CAS NUMBER	OSHA PERMISSIBLE EXPOSURE LIMITS		
				TWA	STEL	CEILING
1	Ammonium Hydroxide (26%)	.2	1336-21-6		35 ppm	
2	Alumina	1	1344-28-1	10 mg/M <sup>3</sup>		
3	Aluminum Hydroxide	5	21645-51-2	NE		
4	Aluminum Oxide	20	1344-28-1	10 mg/M <sup>3</sup>		
5	Amorphous Silica	10	7631-86-9	6 mg/M <sup>3</sup>		
6	Antimony and Compounds	10	7440-36-0	.5 mg/M <sup>3</sup>		
7	Barium Sulfate	10	7727-43-7	10 mg/M <sup>3</sup>		
8	Barium, Soluble Compounds	5	7440-39-3	.5 mg/M <sup>3</sup>		
8.5	Bismuth Vanadium Oxide	22	14059-33-7	15 mg/M <sup>3</sup>		
9	Cadmium Sulfide	20	1306-23-6	5 µg/M <sup>3</sup> (as Cadmium)		
10	Cadmium Selenide	20	1306-24-7	5 µg/M <sup>3</sup> (as Cadmium)		
11	Calcium Carbonate	25	1317-65-3	15 mg/M <sup>3</sup>		
12	Calcium Silicate	5	13983-17-0	NE		
13	Carbon Black	25	1333-86-4	3.5 mg/M <sup>3</sup>		
14	Chromium (III) Compounds	20	vary	.5 mg/M <sup>3</sup>		
15	Chromium Metal	10	7440-47-3	1 mg/M <sup>3</sup>		
16	CI PY 35 (Cadmium Pigment)	25	8048-07-5	5 µg/M <sup>3</sup> (as Cadmium)		
17	CI PR 108 (Cadmium Pigment)	25	58339-34-7	5 µg/M <sup>3</sup> (as Cadmium)		
18	Cobalt Compounds	20	vary			
19	Copper	5	7440-50-8	1 mg/M <sup>3</sup>		
20	Crystalline Silica	5	14464-46-1	.05 mg/M <sup>3</sup>		
21	Dipropylene Glycol- Monobutyl Ether	5	29911-28-2	NE		
22	Formaldehyde	.05	50-00-0	.75 ppm	2 ppm	
23	Graphite(natural)	20	7782-42-5	2.5 mg/M <sup>3</sup>		
24	Iron Oxide	25	1309-37-1	10 mg/M <sup>3</sup>		
25	Manganese compounds	5	7439-96-5	NE	5 mg/M <sup>3</sup>	
27	Mica	15	12001-26-2	3 mg/M <sup>3</sup>		
28	Nickel Compounds	15	vary	.1 mg/M <sup>3</sup>		
29	Propylene Glycol	70	57-55-6	NE		
30	Quaternary Ammonium Salt	5	112-02-7	NE		
31	Quinacridonequinone	5	1503-48-6	NE		
32	Talc	10	14807-96-6	2 mg/M <sup>3</sup>		
33	Titanium Dioxide	30	13463-67-7	10 mg/M <sup>3</sup>		
34	Zinc Oxide	20	1314-13-2	10 mg/M <sup>3</sup>		
35	Zinc Sulfide, Cu Chloride Doped	30	68611-70-1	NE		

TWA= Time Weighted Average (ave. airborne exposure in 8 hr work shift work week)  
STEL= Short Term Exposure Limit (15 minute time weighted average exposure)  
CEILING = exposure not to be exceeded during any part of the work day  
NE = None established

7

**Document 12:** Excerpt of the SDS of Golden Fluid Acrylic paints  
Source: Golden Paints [online].



**SAFETY DATA SHEET:** Gamblin Conservation Colors  
**REVISED:** 10/1/19

## SAFETY DATA SHEET

### SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

#### PRODUCT

**Product Name:** Gamblin Conservation Colors  
**Product Description:** Pigment/Resin Solution  
**Intended Use:** Fine art restoration

#### COMPANY

**Company Name:** Gamblin Conservation Colors  
**Company Address:** 2734 SE Raymond Street  
Portland, OR 97202  
USA  
**Company Phone:** 503-235-1945  
**Emergency Phone:** Local Emergency Room

### SECTION 2: HAZARDS IDENTIFICATION

This material is hazardous according to regulatory guidelines (seeSDS Section 16)

**CLASSIFICATION:** **Flammable liquid : Category 3.**

Carcinogen: Category 2. Specific target organ toxicant (central nervous system): Category 3. Specific target organ toxicant (respiratory Irritant): Category 3. Aspiration Toxicant: Category 1

#### LABEL ELEMENTS:

**Hazard symbol:**



**Signal word:** **Danger**

#### Hazard statement:

H226: Flammable liquid and vapor, H302 acute toxicity H304: May be fatal if swallowed and enters airways. H332 Acute Toxicity, Inhalation, H335: May cause respiratory irritation. H336: May cause drowsiness or dizziness. 351: Suspected of causing cancer, H360DF Reproductive Toxicity(Category 1A)

#### Precautionary statements:

P201 - Obtain special instructions before use.  
P202 - Do not handle until all safety precautions have been read and understood.  
P210 – Keep away from heat/sparks/open flames/hot surfaces.—No Smoking.  
P 235 – Keep container tightly closed equipment.  
P 241 – Use explosive proof electrical ventilating and lighting equipment.  
P 242 – Use only non-sparking tools.  
P 243 – Take precautionary measures against static discharge  
P 261 – Avoid breathing mist/vapours.  
P 271 – Use only outdoors or in a well-ventilated area.



SAFETY DATA SHEET: Gamblin Conservation Colors  
 REVISED: 10/1/19

- P 273 – Avoid release into the environment.
- P280 - Wear eye protection, protective clothing, protective gloves, face protection.
- P 301 + 310 - IF SWALLOWED; Immediately call a POISON CENTER or doctor/physician.
- P303 + P361 + P 353 - IF ON SKIN( or hair ). Take off immediately all contaminated clothing Rinse skin with water/shower.
- P 304 +P340 - IF INHALED; Remove person to fresh air and keep comfortable for breathing
- P 308+ P313 If exposed or concerned get medical attention.
- P 312 – Call a POISON CENTER or doctor/physician if you feel unwell.
- P 331 – Do NOT induce vomiting.
- P 332 + P313 – If skin irritation occurs get medical advice/attention.
- P 370 + P 378 – In case of fire use water fog, foam, dry chemical or carbon dioxide (CO2)
- P405 - Store locked up.
- P501 - Dispose of contents/container according to local, regional, national, and international regulations.

**Contains:** SOLVENT NAPHTHA (PETROLEUM). LIGHT AROMATIC

**HAZARDS NOT OTHERWISE CLASSIFIED (HNOC):** None as defined under 29 CFR 1900. 1200.

### SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

#### CAS NUMBER/OTHER IDENTIFIERS

Name	CAS#	Concentration (%)	Classification (GHS-US)
SOLVENT NAPHTHA (PETROLEUM) LIGHT AROMATIC	64742-95-6	100	H266,H304,H335 H336,H351,H316,H401
CUMENE	98-82-8	<1.1%	H226, H304, H335
PSEUDOCUMENE(1,2,4 TRIMETHYL BENZENE)	95-63-6	<32%	H226, H304, H335 H315, H3192A, H401, H411
XYLENES	1330-20-7	<2.2%	H226, H304, H312, H332, H335, H315, H32092B0, H373, H401

### SECTION 4: FIRST AID MEASURES

**Eyes:** Wash with clean water for at least 15 minutes. If irritation persists, get medical attention.

*Document 13: Excerpt of the Gamblin Conservation Colors SDS  
 Source: Conservation Colors [online].*

**Safety data sheet**

according to Regulation (EC) No. 1907/2006 (REACH)

**1-Methoxy-2-propanol ≥99 %, for synthesis**article number: **3123**Version: **3.0 en**

Replaces version of: 10.10.2019

Version: (2)

date of compilation: 31.08.2015  
Revision: 13.08.2021**SECTION 1: Identification of the substance/mixture and of the company/undertaking****1.1 Product identifier**

Identification of the substance	<b>1-Methoxy-2-propanol</b> ≥99 %, for synthesis
Article number	3123
Registration number (REACH)	01-2119457435-35-xxxx
Index number in CLP Annex VI	603-064-00-3
EC number	203-539-1
CAS number	107-98-2

**1.2 Relevant identified uses of the substance or mixture and uses advised against**

Relevant identified uses:	Laboratory chemical Laboratory and analytical use Formulation (mixing) of preparations and/or re-packaging (excluding alloys) Intermediate Industrial uses Professional uses
Uses advised against:	Do not use for products which come into contact with foodstuffs. Do not use for private purposes (household).

**1.3 Details of the supplier of the safety data sheet**Carl Roth GmbH + Co KG  
Schoemperlenstr. 3-5  
D-76185 Karlsruhe  
Germany**Telephone:** +49 (0) 721 - 56 06 0**Telefax:** +49 (0) 721 - 56 06 149**e-mail:** sicherheit@carlroth.de**Website:** www.carlroth.de

Competent person responsible for the safety data sheet: Department Health, Safety and Environment

**e-mail (competent person):** sicherheit@carlroth.de**1.4 Emergency telephone number****SECTION 2: Hazards identification****2.1 Classification of the substance or mixture**

Classification according to Regulation (EC) No 1272/2008 (CLP)

Section	Hazard class	Cat-egory	Hazard class and category	Hazard statement
2.6	Flammable liquid	3	Flam. Liq. 3	H226
3.8D	Specific target organ toxicity - single exposure (narcotic effects, drowsiness)	3	STOT SE 3	H336

**Document 14: First pages of the Dowanol (1-methoxy-2-propanol) SDS.****Safety data sheet**

according to Regulation (EC) No. 1907/2006 (REACH)

**1-Methoxy-2-propanol ≥99 %, for synthesis**article number: **3123**

For full text of abbreviations: see SECTION 16

**The most important adverse physicochemical, human health and environmental effects**

The product is combustible and can be ignited by potential ignition sources.

**2.2 Label elements**

Labelling according to Regulation (EC) No 1272/2008 (CLP)

**Signal word**      **Warning****Pictograms**

GHS02, GHS07

**Hazard statements**H226      Flammable liquid and vapour  
H336      May cause drowsiness or dizziness**Precautionary statements****Precautionary statements - prevention**

P210      Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking

**Precautionary statements - response**

P304+P340      IF INHALED: Remove person to fresh air and keep comfortable for breathing

**Labelling of packages where the contents do not exceed 125 ml**Signal word: **Warning**

Symbol(s)

**2.3 Other hazards****Results of PBT and vPvB assessment**

According to the results of its assessment, this substance is not a PBT or a vPvB.

**SECTION 3: Composition/information on ingredients****3.1 Substances**

Name of substance	1-Methoxy-2-propanol
Molecular formula	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>
Molar mass	90,12 g/mol
REACH Reg. No	01-2119457435-35-xxxx
CAS No	107-98-2
EC No	203-539-1

Source: Carl Roth [online].